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Specializes in Electrical Parts

Company Builds Up Business Making Castings for Electrical Machinery and Increases Capacity—Bases Swept with Drag Bedded in the Floor—Different Types of Molding Machines Adapted to the Work

ELECTRICAL, as applied to castings, is a term which suggests mystery to many. It induces a hazy idea that metal for such castings must have some properties of which the foundryman has no conception and cannot control in the production. He is familiar with specifications for tensile and transverse strength, but when magnetic properties such as permeability are mentioned, the average foundryman is beyond his depths. He does not clearly understand what is meant, much less does he hope to control the iron so as to produce the quality of high permeability.

Permeability of iron or any other magnetizable substance is the ratio between the number of lines of force passing through a unit area of the substance, and the strength of the magnetic force which produces them.

This may be understood better when it is realized that the current in the wires around a pole piece sets up a magnetic field from one pole piece to the next. This field must make a circuit through the casting holding the pole pieces, up through one pole piece, through the air gap between the armature and the pole piece, through the armature, back to the other pole piece, after crossing the air gap between. The wires in the armature, wound between the teeth of the sheet steel core cut the magnetic field as the armature revolves and a current is set up in them. Now if the casting is not highly permeable it will offer resistance to the magnetic field and thus weaken it.

This being the case, high permeability is desirable only when the metal is part of a magnetic circuit, as in the poles of a generator or the metal connecting the two poles. For this reason, the poles of a generator usually are made of a soft grade of sheet steel, which has the highest permeability of any of the commercial forms of iron. However, in certain cases, where high magnetic density is not demanded, the pole pieces are made of forged, rolled

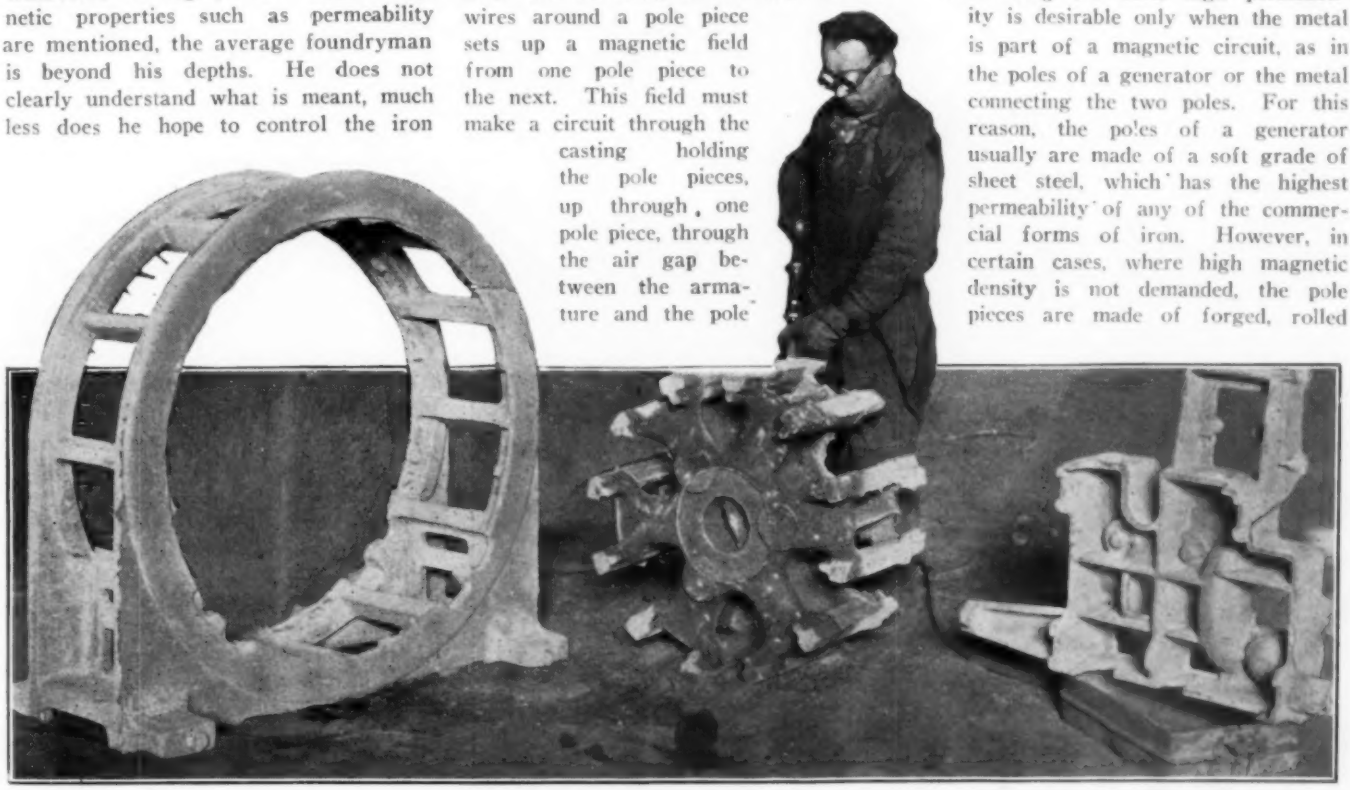


FIG. 1—TYPICAL CASTINGS MADE IN THE ELMIRA FOUNDRY—AT THE LEFT IS A STATOR FRAME—THE CASTING IN THE CENTER IS A ROTOR SPIDER AND THE CASTING AT THE RIGHT IS AN OIL-PUMP BASE

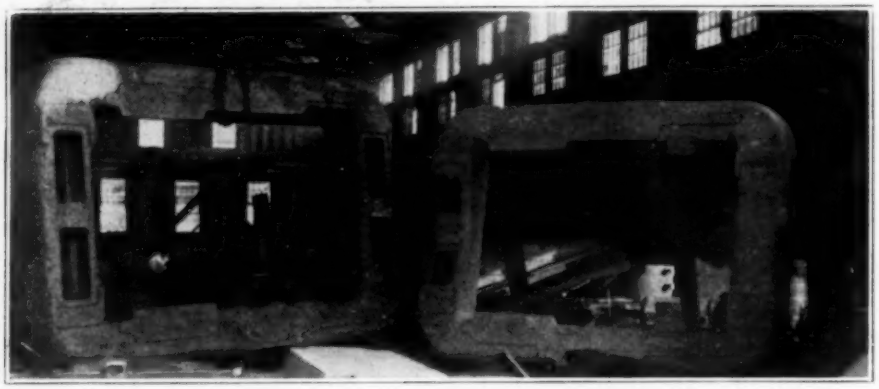


FIG. 2—TWO CAST IRON BASES FOR ELECTRICAL MACHINERY

or cast steel. Nevertheless, in such pole pieces which are solid and do not offer the resistance to internal eddy currents as is afforded by the scale on the surface of sheet iron, loss of energy, and heating from these currents, is high.

The required magnetism is secured in the cast frame either by increasing the cross-sectional area or by using a metal with high magnetic permeability. In many cases the section of metal needed for physical strength is large enough to give a low magnetic density at operating conditions. In cases where light weight is a strong consideration, such as in railway motors, a steel casting frequently is used for the frame, as cast steel has the highest permeability of any of the cast metals. Malleable iron has a permeability about midway between steel and gray iron at the lower densities, coming near the gray-iron line at the higher densities. For this reason, it is used to some extent for the frames of fan and other small motors.

In gray iron, the elements which tend to lower the permeability are manganese, combined carbon and total carbon. The manganese may be kept low by using low-manganese stock and the combined carbon reduced to almost zero by using a high-silicon iron. However, it is more difficult to keep the total carbon low in gray iron melted in the cupola. One firm tried this by using a semisteel made by charging half steel scrap and half 8 to 10 per cent ferrosilicon together with scrap from the mixture. While the original charge, using this mixture, had approximately 1.50 per cent carbon, the iron, as it came from the cupola, contained as high as 3.00 per cent carbon in the first of the heat, which gradually became lower until when near the end of the heat the total carbon would be below 2.00 per cent. Thus, the first iron would be little better than the regular gray-iron and the whole heat was irregular.

Owing to this difficulty of obtaining a uniform product with low total carbon from the cupola, few firms making castings for electrical machinery try to accomplish this. Too, generator and motor frames which are practically the only castings requiring high permeability, do not comprise a heavy tonnage. Thus an iron to give the best results which can be obtained regularly and without undue expenditure may be secured by using a high-silicon, low-manganese stock; and the foundryman does not have to think of permeability.

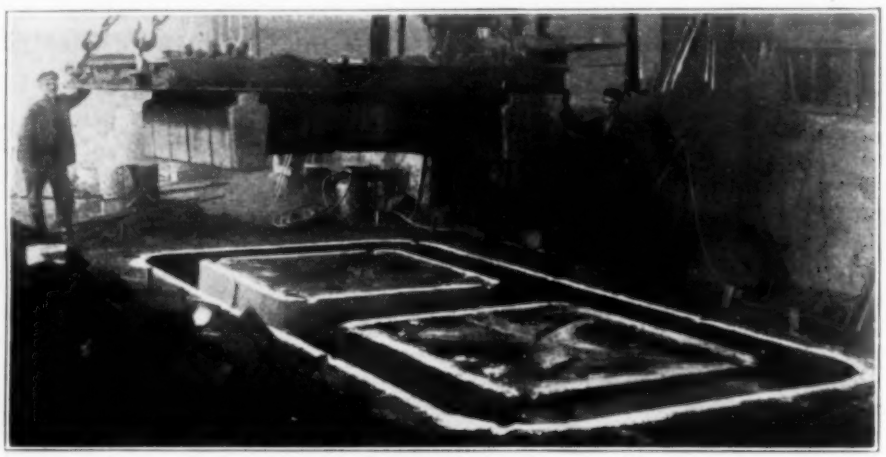


FIG. 4—THE COPE IS MADE IN A BARRED FLASK AND THE CORES ON ARBORS ARE BOLTED TO IT

FIG. 3—THE BASES ARE MOLDED WITH TWO SWEEPS WHICH ARE GUIDED BY AN INSIDE AND AN OUTSIDE FRAME

Molding methods in making electrical goods are extremely interesting and some are peculiar to this class of castings. The plant of the Elmira Foundry Co., Inc., Elmira, N. Y., is a good example of a foundry producing electrical castings. Soon after starting it began to make castings for the General Electric Co., and did this so well and efficiently that in 1916 the General Electric Co. secured control of it, and its work now is devoted entirely to the production of castings for machinery made by that manufacturing establishment.

The shops are served by the Erie and the Pennsylvania railroads and have switching facilities to the Lehigh Valley and the Delaware, Lackawanna &

Western railroads. Three foundry buildings with numerous small buildings of a miscellaneous character house the plant. Each foundry does a different class of work and are described in the order in which they were built.

The No. 1 shop, 228 feet long, is located along the tracks of the Erie railroad at the truncated end of the triangular lot. Next to it is the No. 2 foundry which is 450 feet long by 60 feet wide, and near the base of the triangle, beyond the No. 2 foundry is the latest shop, completed about two years ago. This foundry is 560 feet long by 120 feet wide, so the plant area is filled by foundries of greater length as it broadens from the truncated section.

The heavier work is done in the No. 1 shop and the molding floor, 43 x 228 feet is covered by one 10-ton and one 20-ton traveling crane. The large majority of castings made here are bases for motors or generators, or both. These are molded with sweeps, using templets to outline the mold. As this class of work is one in which the Elmira foundry excels, a descripion of it is of unusual interest.

An idea of the shape of these bases may be gained from Fig. 2 which shows the upper face of two of them. The sides and ends are hollow and contain ribs and bosses which must be molded in. Some of these bases weigh as much as 15 tons; 24 feet is the maximum length and 12 feet the maximum width, while they are made as high as 36 inches.

After a base is cast it is allowed to cool in the mold, the cope being taken off shortly after it is cast and the casting taken from the mold the following day. Then the sand is wet down and enough dug out to give space for the drag of the next mold. This hole is then rammed with sand, using air rammers, and the top is leveled to the height of the floor. Straight edges are laid down and the bed struck to the required size. Two frames consisting of flat, hollow squares of wood are laid on the surface which has been struck. The one frame forms the outside of the base and the other forms the inside edge. Steel plates are laid on the joints to prevent the sand from being cut up as the molders walk over it in sweeping out the mold.

Plates Laid Around Mold

Fig 3, which shows the drag of one of these molds, illustrates the necessity of having plates for the molders to walk on. It also shows the outside sweep, at *A*, and the inside sweep, at *B*. The frames may be noted around the inside and outside edges of the mold. Thus the only patterns needed to make this drag are the two simple frames, together with the inside and outside sweeps and a few loose pieces for ribs and bosses.

After the frames are laid down, the correct distance is maintained between them by dividing sticks which are placed at intervals around the frames. These are finally located by driving stakes at each corner, when the dividing sticks are removed. The inside and outside are swept with core sweeps after the main bulk of the sand has been removed with a shovel. Sometimes these sweeps are the same, but more often they are of a different outline. The surface of the bottom of the mold between the sides, which forms the top of the base, is leveled by sliding the bottom of the sweep across it and by the use of a trowel.

When the drag is swept, paper is placed over the mold to form a parting, and the patterns for the ribs bosses and flanges are set in. These are located by marks on the frame patterns. The pad pieces on the bottom are located by laying a stick from the inside to the outside frame at the designated points, and the molders working from blueprints, and dropping a plumb to a line on the pad pattern. The frames are removed and the cope flask is then set in place and the cores which are formed in the drag, are rammed with facing sand after arbors, soldiers and gaggers have been placed. The remaining portion of the cope then is rammed with air rammers. In the larger molds the cores are rammed on arbors and bolted to the cope flask which is barred. When the cope is rammed, it is lifted off by the crane and set on horses, as shown in Fig. 4.

After cleaning the joint, the frames are replaced and the sand is cut out around the sides and bottom by a sweep to a depth of about an inch more than the thickness of the metal. This inch is filled with facing sand and swept, leaving a space equal to the thickness of metal. Extra pieces attached to the sweep by dowels, form the depth for pads. The mold is then finished and blacked, the edges being strengthened with nails. After this the frames are removed and the mold is skin dried with an oil torch.

FIG. 5—THE SIX STOOLS ON THE STRIPPING-PLATE MACHINE SUPPORT THE MAIN BODY OF SAND AS THE PATTERN IS DRAWN

Locate Cope With Stakes

The cope is finished by taking out the pattern pieces forming the ribs, flanges and bosses; nailing the edges and repairing the corners. It then is set on

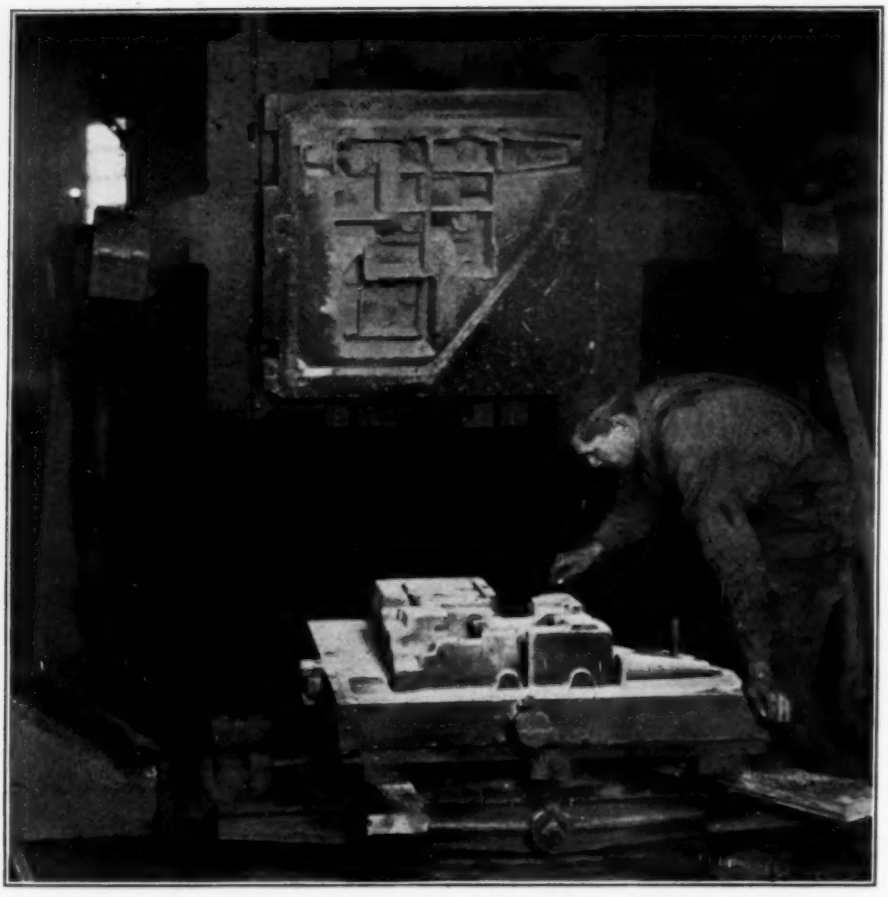


FIG. 6—THE DRAG FOR THE OIL-PUMP BASE IS MADE ON A JAR-RAM MACHINE WITH A ROLLOVER ATTACHMENT

the cope, its position having been determined by stakes at the corners when the mold was made.

The molds are poured from a runner box located in the center. Either one, two or three down gates are used, depending upon the size of the mold. These are run through the cope in the usual way with gate pins. However, in the drag the down gate must be turned to reach the side of the mold. This is accomplished by cutting away the sand to form a groove from the down-gate stick to the edge of the sand in the center part of the mold. A runner stick which can be drawn out the side is then put in and the sand rammed back in place. Before the cope is replaced on the drag the runner and down-gate sticks are withdrawn. Risers are placed at each corner, both inside and outside. For pouring, the cope, or copes, as sometimes two or three copes are used on one drag, are weighted with block weights weighing 2 or 3 tons apiece. In the larger molds the cope is held down with binders.

Work in the No. 2 foundry is quite different from that done in the No. 1 foundry being mostly confined to medium heavy castings made on machines. An oil-pump base, shown at the right, Fig. 1, requiring complicated coring, gives an illustration of how machines are adapted to the work for which they are most fitted, the drag being made on one type of machine and the cope on another. In this case, the drag is made on a jar-ram machine with an independent rollover attachment, both built by the Herman Pneumatic Machine Co., Pittsburgh. Both are operated by air and will handle a flask 50 x 60 inches.

Making the Drag Mold

After the plate is bolted to the table of the rollover machine which sets on the jarring table, the flask is clamped to it. A layer of facing sand is shoveled over the pattern and the flask is filled with heap sand and jolted. After the sand has been struck off and the bottom board clamped to the flask the mold is rolled over and the flask is unclamped from the pattern board. The pattern is then drawn slowly by lowering the draw table with air and vibrating the pattern. The flask which is 36 x 40 inches with one corner cut off to conserve sand and decrease the weight of the mold, is 6½ inches deep. No vents are made nor are rods used to support the green sand cores. Fig 6 shows a drag which has just been made, and the rollover table swung back.

The cope is more simple and is made on a stripping-plate machine

FIG. 7—THE COPE, MADE ON A STRIPPING-PLATE MACHINE, HAS FOUR DRY-SAND CORES—TWO VENTS ARE LOCATED OVER EACH BOSS

built by Henry E. Pridmore, Chicago. It is handled by the traveling crane, as may be noted in Fig 7. This illustration also shows the three down gates at *C*, *D* and *E*, also the two vents, or *whistles* one over each boss. Four dry-sand cores are used in the cope and the green-sand sections protruding from the face of the mold are supported by gaggers and the edges held with nails.

This casting weighs approximately 250 pounds, the metal in the main sections being ¾-inch thick and in the ribs ½ -inch thick. Four men compose the crew making molds. One molder operates the jar-ram machine 3 hours then helps finish and close the molds. Two molders ram the copes and the fourth cores and finishes the molds. The machine is used only part time and could be used alternately on another job if so desired.

Another casting made in a somewhat different way is the rotor spider shown in the center of Fig. 1. This is made on a 36-inch stripping plate machine made by the International Molding Machine Co., Chicago. The spider itself is 30 inches in diameter, and as both sides are identical, the cope and drag may be made from the same pattern. Fig. 5 shows the machine with the cope raised by the crane which serves this floor. The pattern

FIG. 9—THE CHEEK FOR A STATOR FRAME IS MADE WITH A TWO-PIECE PATTERN ON A STRIPPING-PLATE MACHINE

FIG. 8—THE COPE AND THE DRAG FOR A STATOR FRAME ARE MADE ON THE SAME PATTERN BOARD, RUNNER PATTERNS BEING PUT ON WITH DOWELS WHEN MAKING THE DRAG

has been lowered and the six stools which form the parting line between the arms are left standing. These serve to support the sand as the pattern is lowered. In castings of wider dimensions dry-sand cores are placed on the sand formed by the stools and make the strengthening rib between the double arms, but in the smaller castings the arms are formed entirely by the green-sand mold. The spider shown in Fig. 1 is of the wider type on which cores are used as may be noted from the strengthening ribs between the arms.

Gate Through Core In Hub

The molds are gated through a core in the hub using a strainer gate with seven ½-inch holes. A small riser and overflow gate is formed in the side of the hub. A vent, or *whistler* is placed above each punching rib—these are the ribs on the outside which hold the sheet-iron punchings formed around the spider.

The stator frame for a 150-horsepower motor shown at the left, Fig. 1, is made on a stripping-plate machine manufactured by Henry E. Pridmore, Chicago. The pattern, made in two sections, is molded in a cheek which is set between a plain cope and drag. The lower half of the pattern, which is

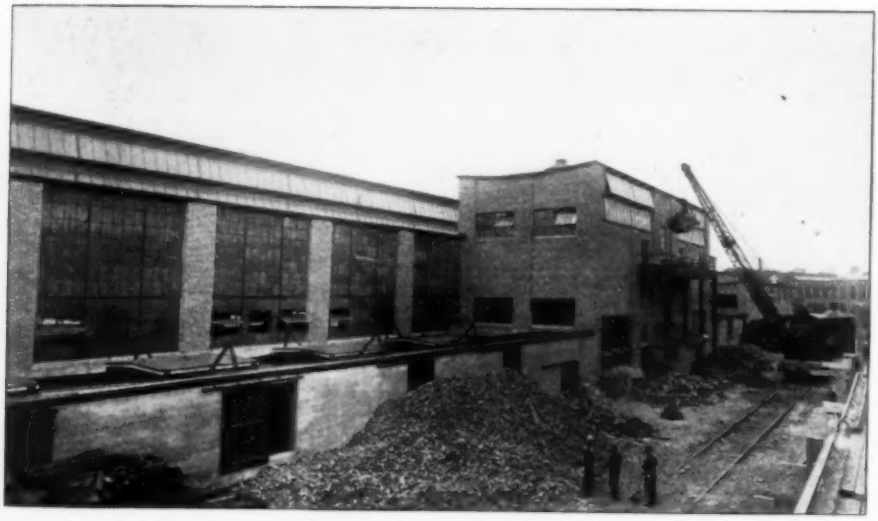


FIG. 10—MATERIALS ARE RAISED TO AN EXTENSION PLATFORM BY A LOCOMOTIVE CRANE

mounted with a stripping plate, is made of cast iron, but the top section which must be handled considerably is made of aluminum. After the cheek flask is put on the machine, a small amount of facing sand is shoveled on the pattern and heap sand is rammed in the mold with air rammers. When the mold is filled to the height of the lower section of the pattern the upper section is put on. While sand can still be rammed with an air rammer in the center of the mold it must be carefully tucked underneath the upper section of the pattern. After the sand is struck off level on top of the cheek the edges are well nailed. Note the nails on the casting at the left, Fig. 1. Then three lifting hooks are screwed into the pattern and attached to the crane. Water is swabbed over the edges of the mold around the pattern and the pattern is rapped at the corners and above each punching rib before it is drawn by the crane. As may be noted from Fig. 9, which illustrates drawing the pattern, the section of rib on the upper portion of the pattern is shorter than that on the lower section. This makes it easier to draw and the stripping plate enables the longer ribs to be drawn readily.

Cope and Drag the Same

The cope and drag are the same except for the runner gates, and are made on the same board, being hand rammed in a barred flask. Fig. 8 shows a cope mold and the pattern board ready to make a drag. As may be noted, this pattern forms the outside edge of the stator frame and two feet. The pattern for one of the feet has been withdrawn and is held by the workman at the right, while the pattern for the other foot is still in the sand. The runner patterns, made of aluminum, are fitted to the pattern board with dowel pins and easily may be lifted off or replaced. As may be noted, the down gate is in the center and feeds metal to the casting through four main runners each of which are divided into two branches near the casting. A pop riser is put on each foot.

An altogether different class of work is done in the new No. 3 foundry, where smaller castings, none of which weigh over 500 pounds, are made. Therefore, the main problem in this foundry is transportation and material handling.

The No. 1 foundry is a long narrow frame building, 43 x 228 feet, with bays on each side. A spur from the Erie railroad enters one end and is used for shipping castings. Another spur along the side of the shop serves the stock yard. Coke is unloaded into a bin and pig iron is stacked in the yard. These materials are taken to the cupola in cars operating on an industrial track and carried to the charging platform by a cable traveling on an inclined plane.

The cupola which is lined to 48 inches is placed near the center in a side bay 16 feet wide, the charging floor being 24 feet long. The next 11 foot length of this sidebay is occupied by the blowers, and another 30 foot space serves as a sand storage room. The core room for larger cores is located in an irregular extension at the south end of the building, approximately 20 x 60 feet. A coke-fired car-type oven, holding two cars, dries the cores. Seventy feet of a side bay, 30 feet wide, on the west side of the foundry is used as a core-room and 50 feet of this side bay is a molding floor. Another side bay 18 x 20 feet serves as a blacksmith shop. Metal, sand and other materials are handled in the main bay by the two cranes already mentioned.

Many Smaller Buildings

West of the No. 1 foundry and between it and the No. 2 foundry is a large space occupied by miscellaneous buildings, including a pattern shop for metal and wooden patterns, and a pattern storage building. These, together with the main office building and entrance, occupy all the space between the two foundries on one side. Back of them is the laboratory and first aid room.

The chemist in the laboratory decides which iron to put into the different mixtures, four of which are used in the several foundries. The phosphorus and manganese in all the mixtures are kept at approximately 0.7 and 0.8 per cent respectively.

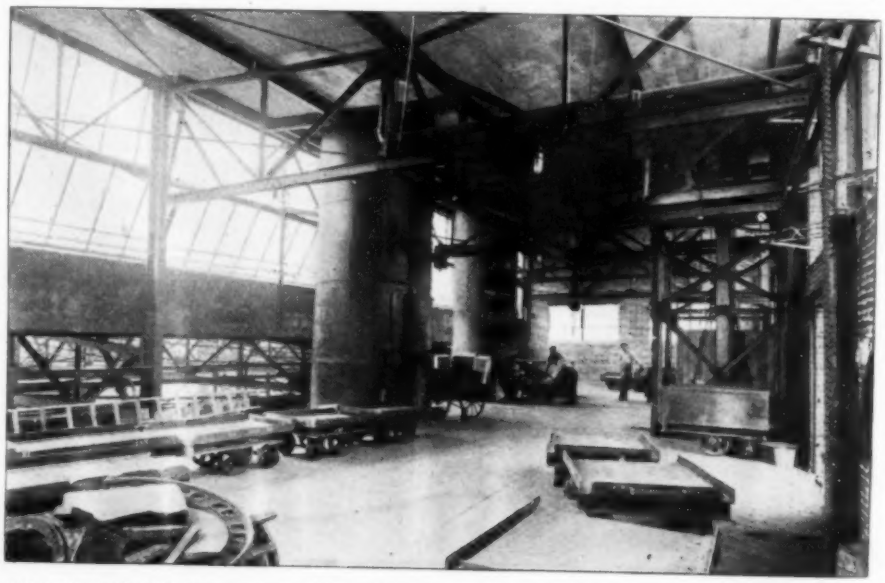


FIG. 11—METAL AND COKE ARE HANDLED ON THE CHARGING PLATFORM CARS OF THE BALANCE TYPE

Sulphur is kept as low as possible, usually ranging between 0.08 and 0.09 per cent. Silicon is varied in the different classes of work, being held at 2.20 per cent in the larger castings, and higher in the smaller ones.

Electric power is purchased from the local public service company, and distributed through the company's local station housed in one of the buildings between the two foundries. In this same area is the compressor building containing five air compressors built by the Ingersoll-Rand Co., New York. Flask storage space, connected with the two foundries by industrial tracks, is covered by a 10-ton traveling crane having a 45-foot span and operating on a 50-foot length of track. Besides, there are in this space between the foundries a machine shop, 40 x 60 feet; a heating plant, from which steam for heating is sent to the foundries; No. 1 and No. 2 sand storage sheds, and a building in which sand is mixed.

The sand-mixing room is equipped with a centrifugal mixer built by Wm. Sellers & Co., Inc., Philadelphia, and an electrically operated riddle supplied by the Great Western Mfg. Co., Leavenworth, Kans. After being mixed the sand is hauled to the foundries in wheel barrows.

Cupolas on East Side

The two cupolas for the No. 2 foundry, lined to 48 and 56 inches respectively, are on the east side toward No. 1 foundry, and next to the stock yard. A spur track extending through the cleaning and shipping room which forms an *L* with the main section of the building, is laid along the entire east side of the shop between the cupolas and sand sheds. Material is delivered to an extension platform on the charging floor by a 5-ton crane having a 60-foot span and traveling on a 75-foot runway. Pig iron and scrap are lifted by a magnet and coke is raised in cars. The charge is weighed on the charging platform. Each of the two cupolas is in a separate lean-to, each on the same side and about one-fourth of the distance from opposite ends of the foundry.

Iron is caught from the cupolas in mixing ladles and from there poured into ladles carried by the three 5-ton traveling cranes which cover the main bay of the foundry, a length of 450 feet with a 60-foot span. In addition to these cranes, three 1-ton cranes having a span of 25 feet and equipped with air hoists operate on a special runway 110 feet long, and serve the floors on which spiders are cast. Four swinging jib cranes also serve special floors.

The molding machines in this shop are principally the stripping-plate type, four jar-ram machines, two of which have rollover attachments, being the main exception. In all, the company has more than 200 machines many of which are adapted to specific castings. Sixty of these are in the No. 3 shop.

After the castings are poured, the molders are through for the day and a night gang dumps the molds and takes the castings to the cleaning room situated in an extension at the end of the building, 60 x 75 feet in area. The crane is used to carry the castings to the end of the shop, where they are put on cars which carry them under the 5-ton crane which travels in the cleaning room at right angles to the main foundry bay. Large castings are handled singly, but the smaller ones are carried on skids.

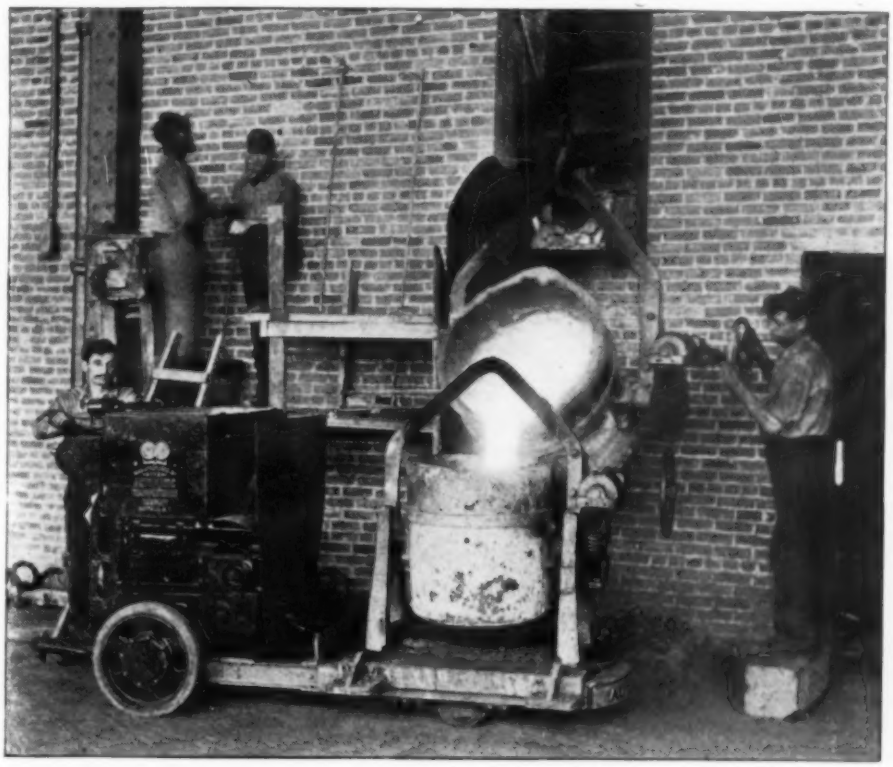


FIG. 12—METAL IS CARRIED TO THE MOLDS BY A BATTERY TRUCK WHICH LIFTS A PLATFORM WITH TWO UPRIGHTS WHICH SUPPORT THE LADLE

Equipped with Sand Blast

The cleaning room is equipped with two sand-blast rooms and five tumbling barrels built by the W. W. Sly Mfg. Co., Cleveland. Two grinders and air chisels also are used. Fig. 1 shows one of the chippers using an air chisel. Castings are carried to the shipping room adjacent to the cleaning department on cars traveling on a narrow-gage track, by the crane, or by the two storage battery trucks with elevating platforms made by the Automatic Transportation Co., Buffalo. Each truck has a capacity of 2 tons.

These trucks also are used in No. 3 foundry situated directly west of No. 2 shop. This foundry, which was erected by the H. K. Ferguson Co., Cleveland, as has been noted, is devoted to light work and is equipped with only one electric traveling crane which is in the cleaning department. However, the columns and trusses have been made strong enough to permit the installation of electric cranes if desired at any future time.

Metal and supplies are taken to the charging platform by a locomotive crane. An electric elevator also is installed for carrying passengers and smaller supplies and for use in case of an emergency. Fig. 10 shows the crane hoisting coke. This also illustrates the type of building. Fig. 11 shows the charging platform and some of the cars used for handling the charges of coke and pig iron. These cars are of the balanced type, 2-ton capacity, built by the Whiting Corp., Harvey, Ill. The two cupolas shown were built by the same company. One of these cupolas is lined to 54 inches and the other to 72 inches. They are situated near the middle of a side bay 29 feet wide which extends nearly the entire length of the shop on the east side. The blowers, made by the General Electric Co., are on the floor level in separate enclosures, 10 feet

square, one on each side of the cupola room.

Metal from the cupolas is caught in mixing ladles and poured into ladles carried on the battery trucks. These ladles are mounted on a base with standards, which rests on the platform of the truck as illustrated in Fig. 12. The passage of the trucks is but slightly obstructed by columns, as the only columns in the main bay, 120 feet wide by 560 feet long, are those in the center line which are 20 feet apart. The cement floor also affords a smooth roadway for the trucks.

Hand Cranes Installed

A novel feature in handling molds is the installation of a number of hand cranes with 2-ton air hoists in the 20-foot sections running across the foundry, parallel to the roof trusses. The crane rails are suspended from the panel points of the trusses at a height of 15 feet from the floor. This height was decided upon because it requires the minimum hand power to move the crane. The hand cranes were built by the Euclid Crane & Hoist Co., Euclid, O., and the hoists were supplied by the Ingersoll-Rand Co. The molding floors are cleaned by a night gang which cuts the sand with a machine.

The sand bins and core room are located in the bay on both sides of the cupola. Seven covered bins, 20 x 30 feet, are provided for different kinds of sand. Hatch doors with large eye bolts on top so they can be opened with the crane are set into each bin. These doors rest at an angle against support when open and serve as hoppers for the bins. The locomotive crane unloads the sand from the cars in which it is received into the bins. The bins also have sliding doors on the outside for shoveling in sand. Sand is taken from the bins through openings into the foundry. Being connected with the foundry the bins are kept warm enough in winter to prevent the sand from freezing.

The side bay is two stories in the 130-foot length in which the core department is located. This department is equipped with three oil-fired ovens of the car-type, each holding two cars, and six ovens of the rack type. The racks are handled with hand-lift trucks. The second story, which is used for pattern storage, extends only to the core oven section at the end of the room. Core sand is mixed in a machine built by the Standard Sand and Machine Co., Cleveland. Fuel oil is stored in two 5000-gallon tanks set in a concrete pit.

The cleaning and shipping rooms, occupying 100 feet at the end of the main bay, are separated from the molding department by a brick wall 12 feet high. Openings are left for two passage ways, 10 feet wide, which extend the entire length of the foundry. The cleaning room is equipped with 11 tumbling barrels built by the W. W. Sly Mfg. Co. A railroad track extends across the end of the building and accommodates three cars for loading. A 5-ton traveling crane, supplied by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., serves to handle castings in the cleaning room and to load them onto cars.

Hot air furnaces, in two units of six furnaces each, are used for heating the building. These are located at the end of the side bay near the shipping department. The hot air is carried by a blower system through overhead ducts with branches extending down to within 6 feet of the floor. This heating system was built by American Warming & Ventilating Co., Elmira, N. Y. Toilet and locker rooms are provided on each side of the cupola room under the charging floor.

Issues New Book on Malleable Iron

Certified Malleable in Transportation and Industry is the title of a booklet issued by the American Malleable Castings association, Cleveland. This book may be obtained by writing to the association.

A brief description of the making of certified malleable is given together with several illustrations. Several pages are taken up comparing it to gray iron castings, steel castings, drop forgings and pressed steel. Some photographs showing the results of pounding and twisting and various kinds of abuse are shown, giving a description of each test. The last five pages are used to illustrate the practical use of malleable iron on trucks, automobiles, tractors, locomotives, industrial machinery and many others.

The book is well written and fully illustrated and should prove of value to anyone who is interested in this subject.

Sees Need of Training

To The Editors:—

The writer is prompted to comment on the recent editorial, "Who Will Make the Castings". A solution of the problem is entirely up to the foundrymen who are in the business to stay, not to the one who thinks "ten years hence I should worry". A few of the far sighted men have begun to develop men for the future in a haphazard way. Some have hit the solution right, but others are laboring under a delusion. They employ a college man to instruct the boys or men whom they wish to develop which is fine as far as it goes.

It is the writer's opinion that a practical man should be the best man to do this work. The man selected should have broad experience; he should be capable of doing any class of work pertaining to the foundry from cupola to office. He should have a deep liking for the work of developing men.

This man could handle instructional work in several foundries if the need required.

Many of the foundrymen of today recognize another factor, that is, the foundry of the future should be as progressive as the modern machine shop in regard to safety and sanitation. This helps to develop the proper morale of the men employed. The humanitarian side of life should be recognized, when it would not be long before the increase of the better class of men would be noticed in the foundry business.

Safety, sanitation and a personal interest in the workmen are essential in the development of the future foundryman, more so than wages.

James Thomas
Dover, Ohio

Issues Data on Pig Iron

The Bethlehem Steel Co., Bethlehem, Pa., has published a 28-page illustrated booklet on chrome-nickel alloy pig iron. Chrome-nickel alloy pig iron is made from an ore found in Cuba containing nickel and chromium and small quantities of titanium and vanadium. It is claimed that this alloy gives castings increased strength and solidity, a better surface, fewer spongy spots, fine machining quality and longer life. The use of this metal is said also to improve working conditions in the foundry, because of the lower freezing point of the molten metal, its great fluidity and longer life in the ladles. The remainder of the book contains descriptions of the various products in which this alloy has been used. On the last three gages some interesting analyses are given.

Foundry Purchases Plant

The George Fuller Sons Iron Foundry, Hallowell, Me., has recently been purchased by E. L. Gedney of Augusta, Me. The company was incorporated in 1840, and the plant is estimated to be worth approximately $20,000. For many years the company was the largest iron foundry in New England.

Heat Factors Govern Melting

Importance of Thermophysics in Melting, Superheating, Pouring and Cooling Iron Illustrated by Effects Enumerated and a Study of Results Obtained from the Combustion of Coke in the Cupola

BY Y. A. DYER

THE principles of thermophysics which operate in cupola combustion and iron founding—as applied to melting, superheating, pouring and cooling processes—may be utilized to decided advantage in reaching definite conclusions as to effects on resultant castings. By reason of the importance attached to each *step operation* in cupola and foundry practice these principles in thermophysics, properly co-ordinated, become a neat problem for the foundryman to master, in his efforts to produce satisfactory castings.

Use Few Heat Units

The actual number of heat units (B.t.u.) utilized in melting and superheating iron is small, compared with the number of heat units it is possible to generate from coke charges. Therefore, the matter of *coke melting ratio* is reflected more in the method of cupola practice than it is in the comparative carbon content of standard foundry coke. That is to say, whether charging and blowing are regulated in such manner as to burn the carbon to generate maximum volume of carbon dioxide gas and minimum volume of carbon monoxide gas. A foundryman may so charge and blow his cupola as to produce at the melting zone two-thirds carbon monoxide and only one-third carbon dioxide gas, thereby lowering the temperature and producing cold iron and creating other undesirable conditions. This would not reflect on carbon content of the coke, for one pound of coke carbon gasified to carbon dioxide gas will generate 14,580 B.t.u., while one pound of carbon gasified to carbon monoxide gas will only generate 4375 heat units, or only about one-third as much heat.

The following tables illustrate the practical difference between using 200 pounds of coke having 90 per cent carbon and 7 per cent ash, and coke with 86 per cent carbon and 11 per cent ash to melt and superheat 2000 pounds of average gray iron:

	90 per cent carbon	86 per cent carbon
Heat units in coke having		
200 x 0.90 x 14580....	2,624,400	
200 x 0.86 x 14580....		2,507,760
Heat units required to melt and superheat:		
2000 x 550.....	1,100,000	1,100,000
	1,524,400	1,407,760
Heat units required to melt coke-ash slag:		
(200 x 0.07) 14 x 900.	12,600	
(200 x 0.11) 22 x 900.		19,800
	1,511,800	1,387,960
B.t.u. balance (by dif.)....		123,840
	1,511,800	1,511,800

In addition to coke-ash slag there will be 80 to 100 pounds of slag formed from sand on iron, dirty scrap, limestone and cupola lining—requiring 75,000 to 90,000 heat units to melt and heat. Therefore, there will be left approximately 1,424,000 to 1,436,000 excess heat units produced by 90 per cent carbon coke and approximately 1,313,000 to 1,298,000 excess heat units produced by 86 per cent carbon coke. Of course, these figures represent perfect combustion—an unapproachable goal in the present constructed cupola. As to how much the excess heat units will be cut down depends on how completely the foundryman is able to burn the carbon, how hot the gases are permitted to escape, and on radiation and conduction losses. There will be an abundance of carbon supplied by either coke to produce gas for melting and superheating iron, to melt slag, expel moisture, etc., provided anything like complete combustion is obtained in the cupola.

Whether a coke burns away too fast by oxidizing action of the carbon dioxide gas depends on whether or not it is too porous or spongy. Therefore, the time required to burn coke will be in proportion to the surface of coke exposed to oxidizing gases in the cupola. If a coke is light and porous, more surface will be exposed, and it will burn away too quickly—permitting iron charges to pass down below true melting zone before being completely melted, hence oxidized and cold iron result, causing hardness and blowholes.

Carbon Dissolved

By reason of the strong affinity of iron for carbon, and the fact that metal charges in a cupola are in contact with incandescent solid carbon and carbon gases while working their way to and through the melting zone, this element is dissolved by the iron during preheating, melting and superheating periods—hence the melting point of the metal is automatically lowered, and consequently superheating degree lowered. The extent to which cast iron and steel are permitted to remain in contact with solid carbon and carbon gases ultimately control their absorbing limit of carbon under the existing conditions; and once the metal's capacity for carbon becomes satisfied, a rejection of the element occurs. We are familiar with this phenomenon by knowledge of carbon being thrown off the metal as *kish* in the foundry—it having become supersaturated with carbon. The degree of absorption of carbon, up to saturation or even supersaturation, will vary with percentage of silicon and manganese present in pig or scrap metals, and with the periods of time they are in contact with hot coke and gases; or the periods of time they are permitted to lie at the critical point above the melting zone, and rapidity with which they are permitted to pass through the zone of fusion, which zone is controlled by the coke melting ratio. In the matter of steel in mixture—on account of its initially low carbon content—the degree of absorption will be relatively lower, hence its splendid carbon dilutive effect on pig or cast scrap mixtures. Therefore, the key to carbon control in cupola metal is primarily a matter of cupola control in operation, the vital factor being the coke melting ratio control.

High Temperature Attained

At the zone of fusion in a cupola the temperature may actually attain approximately 4000 degrees Fahr. but the practical range is between 3150 to 3250 degrees under approximate gas conditions of 60 to 66 2/3 per cent carbon dioxide and 40 to 33 1/3 per cent carbon monoxide—temperature of the two gases being based on LeChatelier's experimental figures.

According to Ledebur, the total heat is one pound of cast iron melted at 2192 degrees Fahr. is 441 B.t.u. The mean specific heat of cast iron, from 32 degrees to t degrees Fahr. as reported by Richards, is $0.12 + 0.000046t$. Therefore, to melt and superheat one pound of white or mottled iron (which melts at about 2150 degrees) to 2500 degrees Fahr. would require (2500 X 0.224) 560 B.t.u., or (560—482) 78 additional heat units for superheating. To melt and superheat one pound of gray

iron (which melts at about 2250 degrees) to 2660 degrees Fahr. would require (2660 X 0.224) 596 B.t.u., or (596—504) 90 additional heat units for superheating.

By reason of lower melting point of white or mottled iron—induced by its higher percentage of combined carbon—relatively less heat will be required for its melting and superheating, compared with gray iron. An attempt to unduly superheat white or mottled iron is quite likely to result in severe oxidation, which not only causes blowholes but decreases fluidity, by reason of the presence of dissolved iron oxide in the metal, and produces hardness and coldshuts. The solidifying point of gray iron is approximately 100 to 150 degrees lower than its fusing temperature, therefore it inherently possesses that amount of superheat, whereas white, or mottled iron inherits practically no superheat. Therefore, while both gray iron and white iron probably solidify at approximately 2100 to 2150 degrees Fahr., there is a wide intervening melting temperature between them—from about 2250 degrees or some higher for gray iron to 2100 degrees or some lower for white iron. This fact largely explains the hot, fluid characteristics of gray iron as compared with less heat and fluidity in white or mottled irons.

Amount of Superheat Varies

Under good cupola working conditions the temperature of iron, as tapped, usually ranges from 2650 to 2700 degrees Fahr.; under average cupola conditions from 2600 to 2650 degrees; under fair cupola conditions from 2550 to 2600 degrees; and under poor cupola conditions, below 2500 degrees. Therefore, under the various conditions, it may be safely stated that from 300 to 550 degrees constitutes the range of superheat attained by white and gray irons above solidifying temperature.

If an iron be tapped from the cupola at about 2670 degrees into a 5000 to 6000 pound mixing ladle, its temperature in the ladle will be around 2600 degrees, and will cool thereafter at the rate of about 8 to 10 degrees per minute. Each subsequent transfer from ladle to ladle lowers its temperature still further. If transferred to a 1000-pound ladle metal will cool at the rate of approximately 20 to 30 degrees per minute—hence the necessity of exercising caution in ladle transfers. The smaller the mixing or transfer ladles, the more heat will be dissipated.

Strictly speaking, cast iron is never in a state of complete equilibrium throughout its cooling processes by reason of the high percentages of impurities exciting constant and variable reactions; therefore, the fact obtains that the temperature at which metal is melted, superheated, poured and permitted to cool has a wide bearing on the character of castings. The temperature at which it is tapped will determine how long it may be held in the mixing ladle. The temperature at which it is poured from transfer ladles will determine solidity, strength, softness, hardness and liquid contraction.

Hot Iron Gives Solid Castings

Numerous tests have demonstrated that gray iron poured at about 2600 degrees will be solid, due to the fact that less graphite will have formed by temperature arrests in the molten metal before pouring; when poured at 2450 degrees the grain will be more open and strength reduced, due to the formation of more graphite; and when poured at 2350 to 2375 degrees blowholes, coldshuts, hardness and brittleness will exist, due to the pouring temperature being too close to freezing point of the metal. If the mold is knocked down and metal exposed to the air, when at a temperature about 1800 degrees (clear cherry red), the metal will be softer and comparatively weaker, but if allowed to cool in the mold to about 1250 degrees (insipient red) it will be of stronger character, by reason of a more stable molecular adjustment. Uneven shrinkage in gray iron is largely due to formation of graphite. These general rules, of course, apply more particularly to a metal of medium silicon and phosphorus content. With high-silicon, high-phosphorus metal the matter of shrinkage is more accentuated, due to the fact that the larger flakes of graphite and the spongy, segregating nature of phosphorus have a more pronounced effect on expansion and contraction.

A white iron, with 0.75 per cent silicon and under, has practically no temperature arrests after being poured and contracts uniformly throughout the cooling period, largely due to absence of graphitic carbon.

It requires approximately 900 B.t.u. to melt and heat a pound of calcium aluminum-silicate slag, and 1846 B.t.u. to expel one pound of carbon dioxide gas from limestone. At about 62 degrees Fahr. the air, if saturated, would contain 4.92 grains of water vapor per cubic foot. With humidity at 65 per cent. the air would contain (4.92 X 0.65) 3.20 grains, or

$$\frac{27{,}000 \times 3.20}{7{,}000} = 12.30 \text{ lbs. of water}$$

vapor per ton of iron melted. It requires 5780 B.t.u. to decompose one pound of water vapor. Coke exposed to the weather absorbs moisture rapidly—as much as 4 to 17 pounds of water per 100 pounds of coke when exposed to drenching for a period of from 2 to 72 hours. Therefore, if wet coke is used there will be a substantial drawing on the heat balance of the cupola to expel moisture from that source. It requires 1091.7 B.t.u. to vaporize one pound of water.

In summing up available heat in coke, heat necessary to melt and superheat iron and melt slag, expel moisture from air and gas from limestone, heat losses, etc., the following theoretical cupola heat balance fairly represents useful energy expended for work and dissipated energy per 250 pounds of coke containing 86 per cent carbon and 11 per cent ash, consumed in melting and superheating 1950 pounds of sandcast pig iron and average foundry scrap:

	B.t.u.	B.t.u.
Heat power of coke: 250 x 0.86 x 14580		3,174,700
To melt and superheat iron: 1950 x 550	1,072,500	
To melt and heat slag: 125 x 900	112,500	
To expel moisture: 12.30 x 5780	71,150	
To expel gas from stone: 22 x 1846	40,600	
Improper combustion: 40 per cent	1,269,880	
Escaping gases: 14 per cent	440,460	
Radiation and conduction: (By dif.)	163,610	
	3,174,700	3,174,700

Melting efficiency:

$$\frac{1072500}{3174700} = 34.10 \text{ per cent}$$

Find Gas Holes in Ammonia Fittings

By H. E. Diller

Question: I am making semisteel castings for ammonia fittings and find small gas holes on machining the castings. Also the castings leak when subjected to the pressure test, due to porous iron. The following mixture is used:

	Pounds
Home foundry scrap	600
Steel rails	400
Pig iron—1.65 per cent silicon	75
Pig iron—4.45 per cent silicon	300
Charcoal pig iron—1.60 per cent silicon	625
Total	2000

What shall I do to overcome these troubles?

Answer: So many things could cause the trouble that it is impossible to say which one of them did it without having more information. The holes may be caused by a poor venting molding sand or an ill vented core as well as by oxidized metal. The former difficulties could be overcome by the use of a freer venting sand and the latter by adding more coke to the cupola or using less blast. Porous spots are caused by internal shrinking which can be overcome to a great extent by proper melting and the use of an iron with approximately 0.2 per cent phosphorus. Such a metal can be secured by using malleable bessemer pig iron.

Foundry Operated on Schedule

Six Forms Serve To Keep Tab on Progress of the Work—Blackboard in Cleaning Room Indicates Jobs To Be Given Priority—Cards Kept in Pockets of Production Board

BY E. THOMAS McENIRY

PREVIOUS to operating our foundries on a schedule basis we merely were furnishing the division which acts as a contributing department to our machine and erecting divisions, with daily production orders showing the machine shop and erecting floor requirements.

This method of ordering made it possible for the foundry division to produce just what parts they saw fit to produce and castings were not delivered always in the order needed. To secure castings in the order in which they are required orders for all castings now are scheduled. As a result we now are getting all parts in proper quantities and at the right time.

On receipt of their schedule the foundry foremen begin laying out their floors and assigning the various jobs to the proper men, making sure that each man has a full day's work ahead, thereby eliminating any chance of a man having to wait for a job.

To assist the foreman in assigning his work, a foundry production booth has been installed. This booth is used by the foreman when he starts to lay out his work. Included in this booth with the calculagraph clock and other necessary equipment is a production board, three pockets of which are allotted to each man. These pockets are the means of graphically presenting order of work for each man. The time card for the job which the man is working is placed in the top pocket. The starting time for the job together with the elapsed time record is impressed from the calculagraph clock to the card by a booth clerk who rings the men *in* and *out* on each job.

The foreman places the time card covering the next job he has assigned to the man in the pocket immediately beneath the top pocket. In the third or bottom pocket the booth clerk places the time cards for all other advance jobs assigned to the man. In this manner the floor situation and order of work per the foreman's layout is visualized.

Fig. 2 shows the time card used to record the actual time taken for each job. These time cards are printed in three colors, yellow, manila and pink. The yellow card is used for bonus jobs, the manila for day work jobs, and the pink for non-productive jobs. The color scheme shows the foremen the percentage of work or men he has on the three classes of work and assists the cost department in arranging their costs in an efficient manner.

Fig. 1 shows the foundry schedule form. These schedules show exactly what castings are wanted and indicates the tonnage of good castings they will total. In addition to this feature the foundry clerk notes the necessary hours that will be required by each foundry division to produce the parts scheduled. These times, or standards, are compiled and furnished by the standards department. The schedules assure a well balanced heat and allow the company to carry a much lower inventory than it ever did before.

A copy of this schedule, Fig. 1, is furnished to all executives, foremen and gang bosses concerned with producing the parts. The schedules are divided into first and second priorities. It is definitely understood that all parts marked *First Priority* must be produced promptly as they are parts required for service orders and cranes in process for early shipment. Parts marked *Second Priority* are for stock, and some of these are included in every schedule to act as a backlog

COPY TO

WEEKLY FOUNDRY SCHEDULE

DATE ISSUED 4/15/1922 FOR WEEK OF 4/17/1922

PATT. NO.	DRWG. NO.	NAME	MATL.	TOTAL QUAN.	M	T	W	TH	F	S	Weight
		(FIRST PRIORITY)									
2032 B	C2032B	Gear (Heat Treat P)	CS	1							60
W 96 A	Roll 38	Jack Base	"	2							2400

FOUNDRY BONUS TIME CARD

2905

PATT. NAME Jib Hoist Drum

PATT. NO. L5802-A

ORDERED FOR 4300

DWG. NO. C6758

OPERATION NO. 1 Molding

MATERIAL Cast Steel

DEPT. NO. 36

PCS WANTED 1 GOOD

REJECTED INSP. O.K. F NF

Pcs. Allowed 1 STD. TIME 2.50

HOT HRS. 2.25 RATE AMOUNT

O.T. HRS. RATE AMOUNT

HRS & RATE TOTAL PAY

FOUNDRY PRODUCTION ORDER

FROM PLANNING DEPT.

ORDER NO. 485

DATE 4/15/1922

NO. PGS 1 PG NO. 1

NO. PCS.	PATT. NO.	MAT'L	NAME		REQUIRED FOR
2	L6249B&1	CI	Cylinders	C7222	Crane 4228
1	2032 [illegible]	CVS	Gear		
1	L 501	CS	Segment	C1355.	" 4299
1	L5802 A	CS	Jib Hoist Drum	C6758	" 4300

FIG. 1—ABOVE—WEEKLY SCHEDULES GIVING PRIORITY OF PRODUCTION FOR CERTAIN CASTINGS ARE SENT TO THE DIFFERENT DEPARTMENTS FIG. 2—INSERT—FOUNDRY BONUS TIME CARD FIG. 3—AT THE RIGHT—FOUNDRY PRODUCTION ORDER

DF-285

REPORT OF CASTINGS SHIPPED FROM NO. 36

Main Office
Fdry. Office
Platform

Date Shipped 4/22/22

Date of Heat 4/20/22

QUANTITY	PATT. NO	ITEM	C. I.	S.S.	B.R.	C.S.	C.V.S.	MOULDS MADE	CASTINGS IN MOULD	SHIPPED FROM NO. 36	PRICE EACH	TOTAL PRICE	WEIGHT EACH	TOTAL WEIGHT
1	2032B	1												
		35												
		36												
										Signature	F. Watson.			

FIG. 4—ALL CASTINGS PASSED BY THE INSPECTOR ARE COUNTED AND POSTED ON THIS FORM

The pattern shop copy of these schedules acts as a master requisition on the pattern shop for patterns. The schedules are always released several days in advance of the day the castings are to be poured thereby giving the core room department ample time to complete its portion of the work. Any parts ordered after the release of the master schedule are classified by the planning department as to priority and added to all foundry schedules by the foundry clerk who also issues individual pattern requisitions to the pattern shop for an additional patterns required.

On receipt of the superintendent's tonnage O. K. the schedules are released to all concerned. The required personnel to complete the schedule is then assigned by the foreman.

Each day a mold report, Fig. 7, is made out in the foundry production booth by the booth clerk. The report shows all parts molded that day, the molder's number, and the number of pieces molded. The mold report also serves as a check on progress and assures all concerned that every part of the schedule is being maintained.

The mold reports are checked and signed by the foundry foreman each day. They serve as a check on his departmental efficiency, because the actual time taken for each job can be compared against the standard time allowed, as each foreman receives the time cards showing the time spent on each job. Any jobs showing high or low efficiencies are immediately investigated by the foreman and the rate setter who make it their business to find out the trouble and then suggests methods to overcome it wherever this is possible.

After the parts scheduled are all molded the necessary charge of metal to produce the castings required is computed by the general foreman of the foundry and orders are issued to the charging floor boss to cover the required tonnage of raw material.

Upon completion of the heat we issue a poured report, Fig. 5, which shows just what parts were poured, also the heat treatment that is required, if the parts are steel. This report is issued to all par-

-SHORTAGE-

"MACHINE SHOP IS WAITING FOR THESE CASTINGS"

AMOUNT	PATTERN	MATERIAL	H. T.	AMOUNT	PATTERN	MATERIAL	H. T.
1	2032B	C.S.	R				
1	L5802A	C.S.	-				
1	L 501	C.S.	R				

DAILY MOULDING REPORT

MATERIAL Cast Steel

MAN NO	PATTERN NO.	AMOUNT	MAN NO.	PATTERN NO.	AMOUNT
2501	2032 B	1			

Signed: R. Burke

DEPT Foundry Steel Floor DATE 4/18/1922

POURED REPORT 4/2

Steel Molds Poured 4/20/1922

Foundry Inspector is requested to advise Foundry Office the co
of these castings as soon as possible:

Blow 1- #4543		Blow 2- #4544		Blow 3- #4545	
1	2032 B (HTP)	1	CT 74	1	L5802A
2	W96A	1	L2622	1	360
4	L6878	1	294F (HTR)	1	L7411
2	615 U (HTP)	1	L 501	2	501 B
(Test Bars)		(Test Bars)		(Test Bars)	
3	501 B	1	L2628	2	384 A
(Test Bars)		(Test Bars)		(Test Bars)	

FIG. 5—AT THE LEFT—A RECORD IS KEPT OF THE MOLDS POURED FROM EACH HEAT FIG. 6—ABOVE—A BLACKBOARD INSTALLED IN THE CLEANING ROOM CONTAINS HEADINGS AS SHOWN FIG. 7—INSERT—THE DAILY MOLDING RECORD INCLUDES THE MOLDER'S NUMBER, PATTERN NUMBER AND NUMBER OF MOLDS MADE

ties concerned and acts as a progress check and order on the oven man to heat treat the parts as specified. If for any reason a part scheduled was not poured the part is again posted to the schedule for the next heat.

A large blackboard also has been installed on the cleaning floor. The assistant superintendent posts on it the part number of any castings he desires to be cleaned or heat treated immediately. The board is 28 x 38 inches and contains headings as indicated in Fig. 6.

When heat treating and cleaning the castings preference is given to those posted on the blackboard. After being cleaned they are loaded into cars by an overhead crane. Previous to loading, the castings are inspected by the foundry inspector. All castings passed by the inspector are mounted and posted to heat sheets, Fig. 4, by the load man. Any parts scrapped or held up for repair are so reported by the foundry inspector. Orders for scrapped parts are always rescheduled and the repair castings are closely followed up by the foundry clerk to assure early delivery.

The heat sheets are immediately forwarded to the planning department and others concerned. From the heat sheets which show the net result of the pour in good castings, the foundry efficiency is computed by the cost department. The heat sheets show what parts were produced and act as a bill of lading to the planning department. The amounts are posted to the rough stock inventory cards, and requisitions, together with the necessary time cards, etc., are dispatched to the machine shop assignment foreman who designates on the rough stock requisition the location to which he desires the casting or castings to be delivered.

The time cards then are filed in the machine shop booth by the booth clerk of the machine shop and the rough stock requisitions are dispatched to the casting yard department which make the delivery.

The method described informs all concerned as to the status of any part required, from the time the order is received by the planning department from the engineering department, to the time the part is actually delivered to the machine shop. This follow-up method assures efficient production of castings and can be used by any company operating a foundry division which acts as a contributing department to its machine and erecting departments.

Ohio Foundries Show Increased Melt

RETURNS from 68 of the foundries represented in the Ohio State Foundrymen's association indicate the actual melt has increased from about 22 per cent of the normal melt in January, 1922 to slightly above 50 per cent in June. By plotting the figures in the June trade report of the association and consolidating them with the statistics published in the 1921 *Year Book*, the continuous trend of actual melt, as shown in the accompanying illustration, is obtained.

The trade report for June is particularly interesting because for the first time purchases of iron and scrap have been classified. The 68 reporting foundries, having a normal melt of 23,678.6 tons, actually melted 12,016.8 tons. During the month 2518.5 tons of pig iron were purchased in the spot market and 5352.5 tons on contract. While figures for comparison are not available, it is believed the ratio of contract buying to spot purchases is higher than in 1921 and earlier in 1922. Approximately 2200 tons of scrap iron were received in June, including 1590 tons of No. 1 machinery, 45 of railroad and 665 of miscellaneous grades, principally stove plate. Pig iron on hand on July 1 inventoried at 18,481 tons and scrap at 5917 tons. The entire report for June may be summarized as follows:

	Tons	Per cent of normal melt
Normal melt	23,678.6	100.0
Actual melt	12,016.8	50.7
Pig iron received	7,871.0	33.2
Spot 2518.5		
On contract 5352.5		
Scrap iron received	2,303.1	9.7
No. 1 machinery 1592.5		
No. 1 railroad 45.0		
Miscellaneous 665.6		
Pig iron on hand July 1	18,481.3	78.0
Scrap on hand July 1	5,917.2	24.9

Owing to the fact that beginning Jan. 1, the member foundries reported scrap and iron received and on hand, instead of iron only as in 1921, the graphs showing the amounts of these materials on hand and received are not continuous. The proportionately higher values, shown since January as "stock on hand" and "stock received," are due to the inclusion of scrap with pig iron.

Interpreting these figures in the light of the tendencies shown by the chart, it appears that the actual melt has been slowly increasing during the first half of 1922, while the stocks of pig iron on hand have remained almost stationary at a value fluctuating between 70 and 80 per cent of the normal melt. Therefore the iron which has enabled foundrymen to increase the melt from 20 to 50 per cent in this period has been purchased, and this is indicated by the rise in buying from about 6 per cent in December, 1921, to 33.2 per cent in June, 1922.

Assuming that the strikes do not seriously affect the foundry industry and that the foundries will continue to maintain supplies of iron equal to about 75 per cent of the normal melt, it can be expected that pig iron purchases will rise or fall in accordance with the actual melt. This indicates that the industry in Ohio is on a much more stable basis in the last half of 1921, when, according to the chart, stocks of iron were drawn on to meet the needs of an increased melt in October, while due probably to uncertainty over future demand castings, iron was not purchased to recoup the depleted stocks.

The trade reports of the Ohio State Foundrymen's association are issued from the new offices of the organization, 511 Wade building, Cleveland, A. J. Tuscany is secretary-manager.

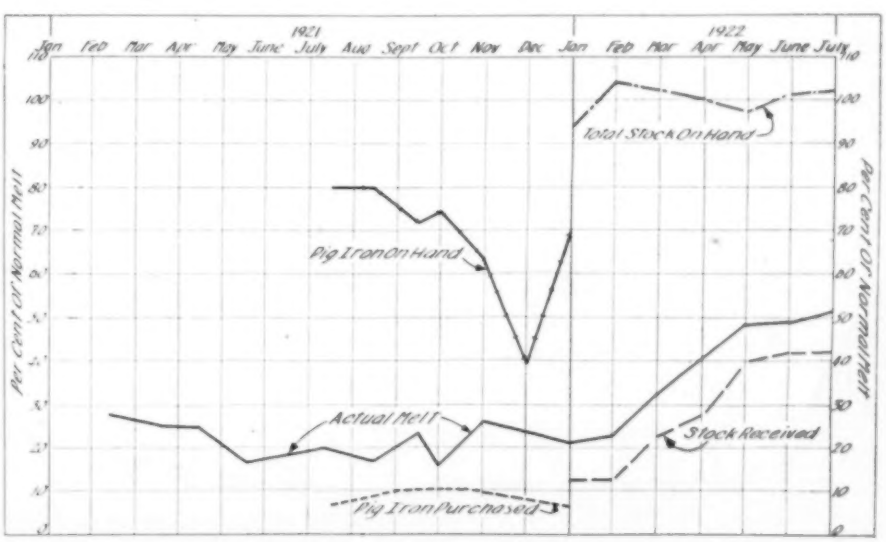

1921
1922
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec Jan Feb Mar Apr May June July
Per Cent of Normal Melt
Total Stock On Hand
Pig Iron on Hand
Actual Melt
Stock Received
Pig Iron Purchased

CHART SHOWING THE TREND OF MELT IN OHIO FOUNDRIES

Molding an Evaporator Belt

The Overhang, Top and Bottom Was Built Before the Mold and Core Were Separated Thus Insuring an Even and Accurate Thickness of Metal in the Casting

BY GEORGE BOYS

LOCAL custom, available rigging and crane capacity determine the manner in which the foundries engaged in the manufacture of sugar mill machinery go about making that part of the evaporator unit known as the steam belt. These castings, one of which is shown in section in Fig. 1, range from 12 to 18 feet in diameter and stand from 5 to 7 feet high. The smaller sizes usually are cast in the form of a one-piece circular casting, but the larger sizes are split in halves for convenience in transportation.

The usual method, where the casting is made as a single unit, is to sweep out a core print; then to build a core and lift it onto the core carriage. The outside wall then is built up to the top shoulder where a lifting ring is bedded on and a section of a pattern blocked into place to form the neck and also the top flange. After the entire outside wall has been loamed and finished, the top lifting ring supporting the upper overhang is lifted off and then both parts of the mold are placed in the oven to dry.

In a mold made in this manner the thickness of metal, especially at the shoulders, may vary to a considerable extent. Clay balls are placed about 2 feet apart in a ring on the face of the lower shoulder. The core is lowered into place and then lifted out. The flattened balls of clay indicate the height of the space between the shoulder of the mold and the core. In like manner balls of clay are placed on the upper shoulder of the core before the upper lifting plate of the mold is lowered into place. The plate is lifted off and the clay indicates the extent of the space provided for the metal. If the space is too little it may be increased by rubbing away some of the loam thickness, but if the space is too large, the usual custom is to ignore it unless it is extreme. In the latter case it may be necessary to spread a thickness of loam either on the cope shoulder or drag shoulder depending on whether the discrepancy exists on the top or bottom. This additional thickness necessarily must be dried, which usually means that the mold or core must be returned to the oven and also means that the casting schedule will be delayed by an additional day. On account of this latter factor the foundryman is inclined to wink at irregularities departing from a uniform thickness, with the result that cooling and contraction strains are set up in the casting which cause distortion and sometimes rupture.

All the foregoing features were given consideration before a method finally was adopted and placed in operation. This method, shown applied to a 13-foot ring in Fig. 1, has eliminated all risk of uneven thickness and consequently has been responsible for the production of castings true to design and presenting a minimum of trouble in machining and assembling.

The job was commenced by digging a hole in the floor for a 4-inch spindle base or step. This base which was described in detail in THE FOUNDRY, page 368, May 1, 1921, and which is shown in the accompanying illustration, Fig. 2, is 36 inches square on the bottom. When rammed level and solid in a hole it may be relied upon to retain its position and insure accuracy where it is necessary to take out and replace the spindle several times while preparing any given mold. After placing the spindle in position, a straight sweep was attached to the arm and a level bed was prepared upon which to set the foundation or building plate. The bed was prepared on a level floor reasonably solid and firm enough to support the assembled mold.

After firmly bedding down the bottom plate centered on a spindle, a course of brick was laid on the plate with the exception of the center where the sweep

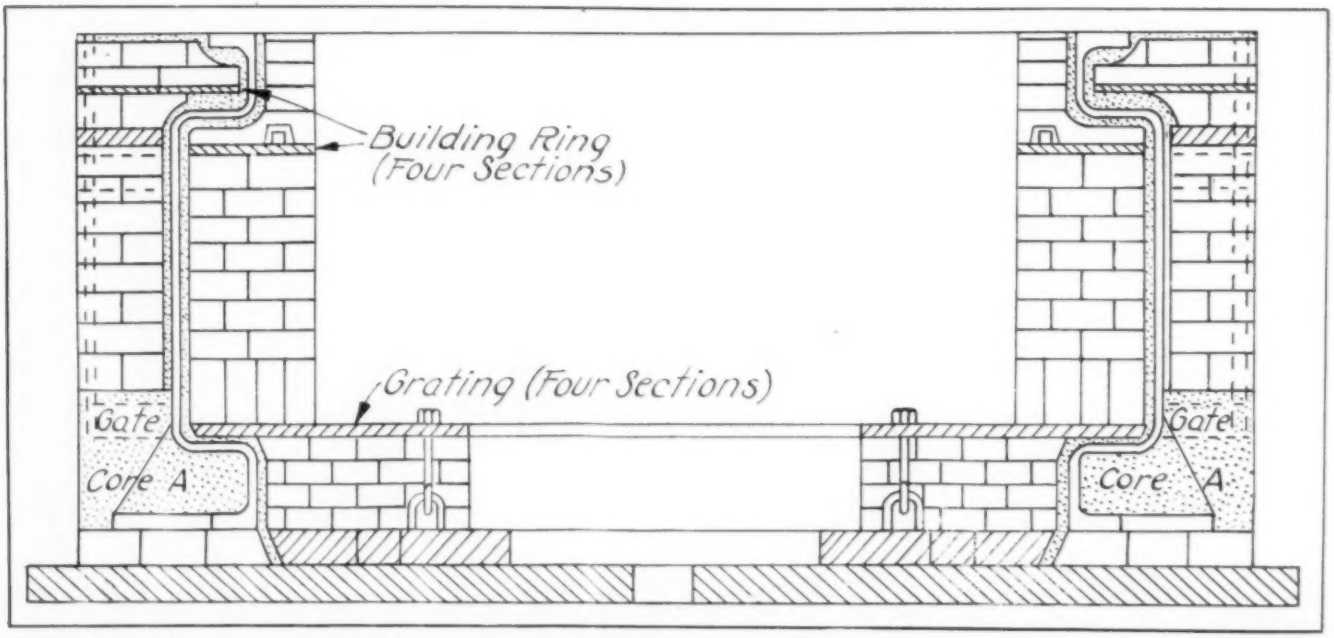


FIG. 1—SECTIONAL VIEW OF STEAM BELT MOLD SHOWING DETAILS OF CONSTRUCTION—WITH THE EXCEPTION OF THE STRAIGHT WALL, THE CORE AND MOLD ARE BUILT AGAINST EACH OTHER THUS INSURING A UNIFORM THICKNESS OF METAL ON THE UPPER AND LOWER SHOULDERS

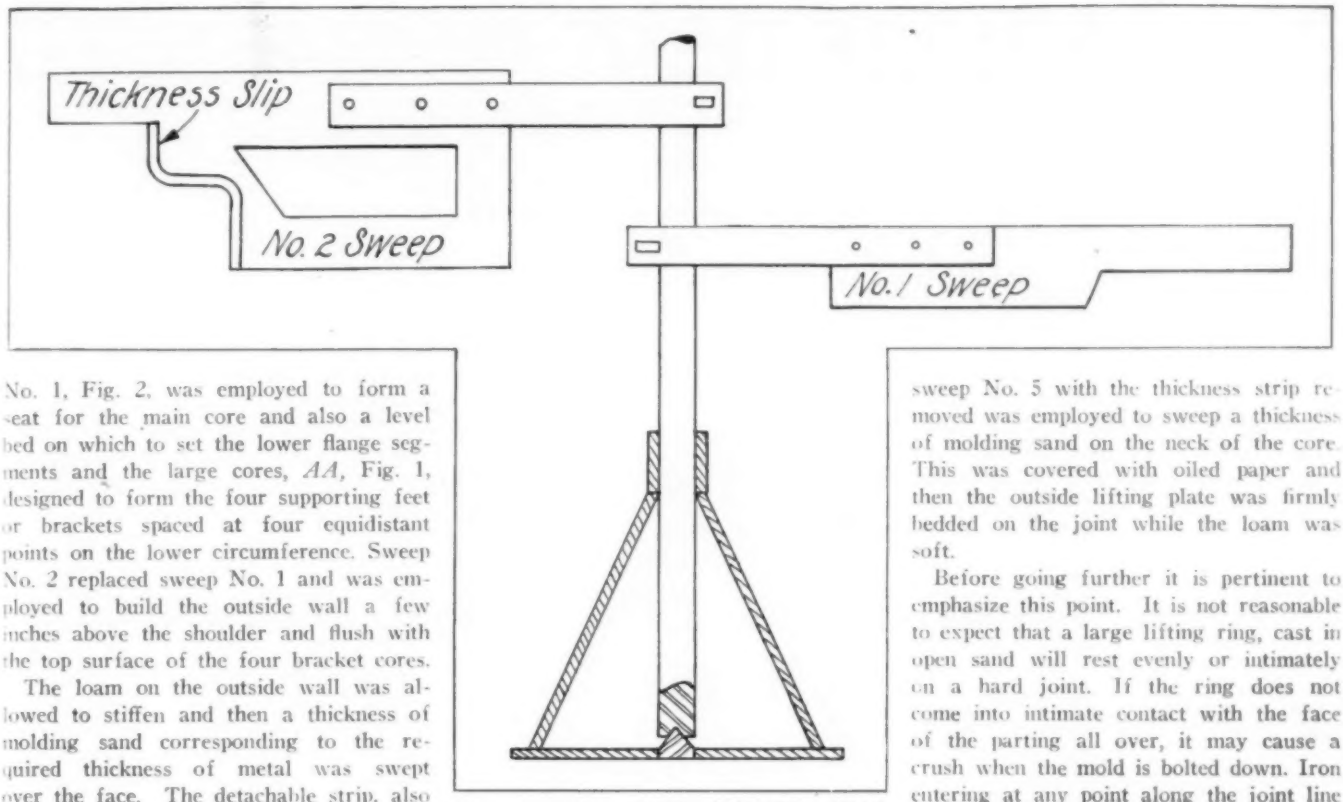


FIG. 2—THIS TYPE SPINDLE SEAT HOLDS THE SPINDLE WITHOUT ANY OUTSIDE SUPPORT

No. 1, Fig. 2, was employed to form a seat for the main core and also a level bed on which to set the lower flange segments and the large cores, *AA*, Fig. 1, designed to form the four supporting feet or brackets spaced at four equidistant points on the lower circumference. Sweep No. 2 replaced sweep No. 1 and was employed to build the outside wall a few inches above the shoulder and flush with the top surface of the four bracket cores.

The loam on the outside wall was allowed to stiffen and then a thickness of molding sand corresponding to the required thickness of metal was swept over the face. The detachable strip, also corresponding to the required metal thickness, was removed from the edge of the sweep for this purpose. Oiled paper was spread over the parting and after the core lifting plate had been lowered into place and adjusted, the brick work was carried up as high as the first shoulder. At this point a substantial grating in four sections was set in place as shown in Fig. 1. Stiff steel bars, wedged under staples, held the joints together on the cantilever principle and short bolts on the inner circumference held the grating securely anchored to the main core plate as shown in Fig. 1. Sweep No. 3 was attached to the spindle arm and the core was built up to the top. It was loamed and finished and then lifted out and placed temporarily on the core oven car. After the core was placed out of the way, sweep No. 4 was bolted to the spindle arm and the outside wall of the mold was built up to the top shoulder as shown in Fig. 1. A parting was made at this point and then the core was lowered back into its place in the mold. Strips of old bags were packed in the opening between the walls and then sweep No. 5 with the thickness strip removed was employed to sweep a thickness of molding sand on the neck of the core. This was covered with oiled paper and then the outside lifting plate was firmly bedded on the joint while the loam was soft.

Before going further it is pertinent to emphasize this point. It is not reasonable to expect that a large lifting ring, cast in open sand will rest evenly or intimately on a hard joint. If the ring does not come into intimate contact with the face of the parting all over, it may cause a crush when the mold is bolted down. Iron entering at any point along the joint line and finding its way into any hollow spaces under the ring will *kick back* and cause a blown casting. If the joint line was in a position where it could be examined and if necessary daubed with loam after the mold was closed this feature would not be of such importance. By referring to the illustration, Fig. 1, it at once will be apparent that when the lifting ring is set on the outside wall for the last time the joint line is out of sight and therefore cannot either be examined or repaired.

The outside wall, including a grating to carry the overhang, was built up flush with the top of the core. A straight

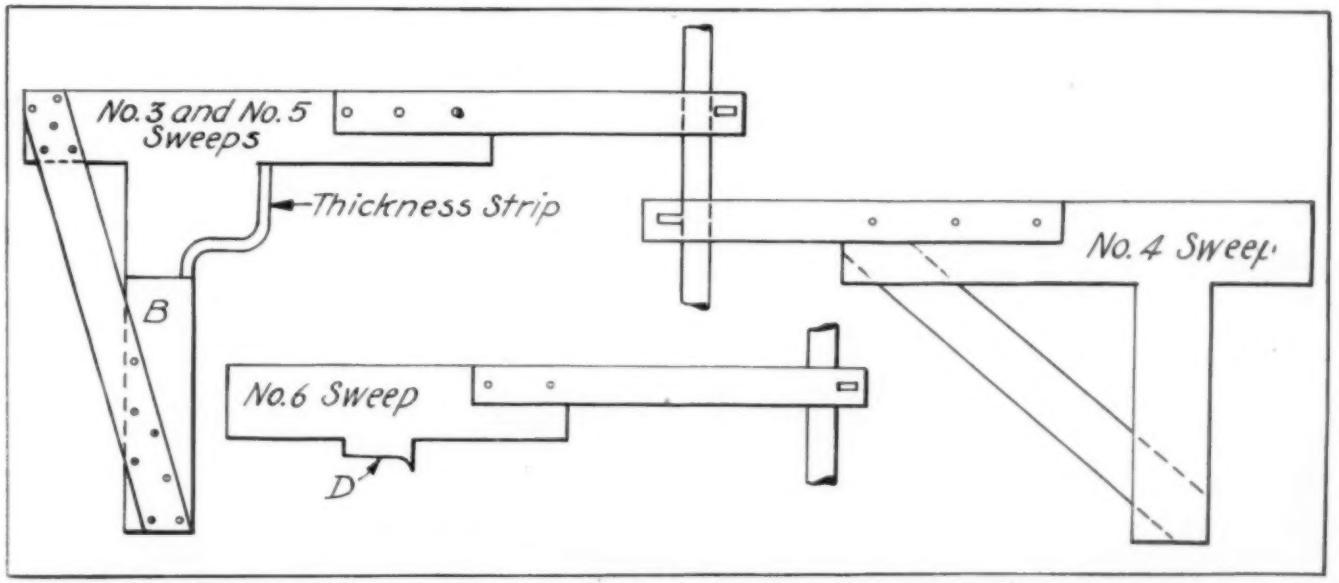


FIG. 3—THE SWEEPS IN THIS ILLUSTRATION ARE USED IN THE ORDER IN WHICH THEY ARE NUMBERED—THE UPPER LEFT HAND SWEEP, NO. 3, IS FIRST USED JUST AS IT IS SHOWN COMPLETE—IT THEN IS TAKEN OFF THE SPINDLE AND REPLACED BY SWEEP NO. 4—AFTER NO. 4 HAS SERVED ITS PURPOSE IT IS REMOVED AND REPLACED BY SWEEP NO. 5 WHICH IS NO. 3 WITH THE THICKNESS STRIP AND THE EXTENSION *B* REMOVED

sweep, 6, Fig. 3, provided with a suitable member, *D*, was employed to form the upper flange in the mold and also to bring the top of the core and the top of the mold into a true plane so that later the covering plate which was swept up independently of the mold, might rest on both parts evenly.

The sand thickness between the neck of the core and the mold was loosened and partly dug out and then the upper part of the mold supported on the lifting plate was removed, finished, blacked and placed in the oven to dry. Suitable marks were placed on the joint before the ring was lifted off. After the joint and core had been marked in a similar manner a 6-arm cross was attached by suitable slings to six lugs on the core plate. The core then was lifted out, finished, blacked and placed in the oven to dry. The outside part of the mold was cleaned out, then finished and blacked after which it was dried.

The mold was assembled in a pit in the floor. Slings were attached to the lugs on the foundation plate and upright gate cores were built up against the face of the brick work on the outside at four points to connect with the two sets of gates on opposite sides of the mold as indicated in Fig. 1, and then the space between the mold and the wall of the pit was filled with sand and rammed up in the usual manner.

A 4-arm cross, corresponding with the four lugs on the bottom plate was used to bind the mold. We also used a number of weights because it was felt that four binding points were too far apart for a job of this character. The cross and plate had been made before my time, but if I were to make new rigging for this job I should place at least six lugs on the plate and make a cross with six arms to use with it.

After the casting was poured, the brick work was dug out from under the flange on the outside and from under the shoulder on the inside. The steel bars used for binding the grating sections together also were slacked and then a channel was cut through the brick work on the inside at four equidistant points from top to bottom. The adoption of these precautions allowed the casting to contract without setting up any internal strains.

British Foundries Decrease Accidents

SIDELIGHTS are thrown on safety conditions in British foundries by a paper presented by A. W. Patmore at the Institution of British Foundrymen, Birmingham conference, 1922.

It has been stated that during the last twelve months an average of three men have been killed each month and 5 per cent of the workers in foundries are injured annually in Great Britain. The following are some of the causes of accidents given by Mr. Patmore. In placing drag, fingers may be caught or foot squeezed. When riddling sand the molder may cut his flesh on buried slugs. A poor vent may cause an explosion. In placing cope or top, fingers get trapped while watching guide marks. The molder may fail to see that bolts or clamps are used instead of cotter pins. If a lead runner is too wet it may blow. In pouring men may fail to wear proper protective clothing. If cranes are not equipped with gongs, men do not have time to get out of the way while molten metal is being carried overhead. Failure to insist that workers wear glasses often causes eye troubles. Accidents occur from bursting emery wheels. This danger can never be wholly eliminated, but it may be guarded against.

If a manager of a foundry is really trying to improve conditions he will as far as he is financially able furnish proper safeguards and ventilation. Mr. Patmore says that British foundrymen seem to realize the importance of these factors but that there are still a great many plants in Great Britain where conditions are far from what they should be.

If the manager wishes to make his foundry safe he must be sure that the spirit of safety be thoroughly instilled in every employe and that everyone is working to decrease the number of accidents to the minimum. One of the big steps toward safe guarding life is the proper instruction and training of new employes. The old theory that he will learn by experience too often brings disaster.

Mr. Patmore suggests that to impress the importance of safety on the minds of the superintendent and foreman, the cost of each accident with its subsequent loss of production should be charged to his department. No matter how many safety devices are installed or safety campaigns conducted, real success can come only with the co-operation of the men. With this in mind, it has been suggested that each worker should be asked to sign a pledge in which he promises to (1) keep himself fit and in good health; (2) report to the company first aid room for treatment upon receipt of the smallest wound or scratch; (3) use all safety appliances, clothing and guards provided and to see that they are kept and used in their proper places; (4) not to wear loose clothing around moving machinery; (5) not to use unsafe tools but to report them to his foreman; (6) to wear goggles when pouring, grinding and chipping or performing any operation where material may fly and cause injury to the eye; (7) to keep the floor space in the immediate vicinity of work clear of all objects over which workmen may fall; (8) to be careful in handling and piling material so that no serious injury may result to passersby; (9) to be just as careful of a fellow workman's life as he is of his own, remembering that he, too, may have dependents; (10) to report to the foreman at once all unsafe conditions and practices which may come to his knowledge.

The motion picture has proved a help in Great Britain in helping the men to realize the dangers and to show them the remedies.

In the home office regulation of 1917 is a long section given over to a detailed explanation of what provision must be made in every foundry for first aid. They are briefly: (1) There must be a first aid box for at least every 150 persons; (2) Every foundry of over 500 must have an ambulance room; (3) Cupboards for first aid supplies must be marked with white cross or red; (4) Nothing except first aid appliances shall be kept in the cupboard; (5) Ambulance room shall be under nurse or other qualified person; (6) Any foundry employing 500 or more shall have an ambulance carriage or definite arrangements for the use of one within reach of telephone.

Coast Foundry Acquires New Facilities

The Commercial Engine Co., 2424 Porter street, Los Angeles, Cal. has increased its capital stock from $75,000 to $200,000 and shortly will change its name to the Commercial Iron Works. This firm recently purchased the Ohio Foundry, Inc., Vernon, Cal. The Commercial company is erecting a modern steel and concrete building, 90 x 164 feet. Equipment from the Ohio foundry will be moved to the new building when it is completed.

Cracking in Aluminum Alloys

Theories of Causes of Cracking Are Enumerated and Micrographs Shown To Illustrate Individual Cases—Cracks Prevented by Judicious Use of Risers and Chills and by Other Methods Illustrated

BY ROBERT J. ANDERSON

LIQUID shrinkage, that is, the contraction in volume in the liquid state, is the amount of diminution of volume that occurs on cooling a metal or alloy at any temperature above its melting point to any other temperature above its melting point. The liquid shrinkage of aluminum, and some of its light alloys, is a nearly linear function of the temperature, as the density in the liquid state varies quite uniformly with the temperature.

The solidification shrinkage is the contraction in volume of a metal or alloy on passing from the liquid state at the freezing point to the solid state at the melting point.

The solid shrinkage is the contraction in volume that occurs on cooling a metal

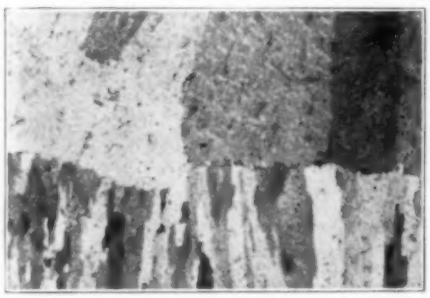


FIG. 1—FISSURES AT JUNCTURE OF SETS OF COLUMNAR CRYSTALS IN 92:8 Al-Cu ALLOY; ETCHED WITH NaOH; OBLIQUE ILL.—X 5

or alloy in the solid state; it may be determined over any temperature range from the formula for expansivity. Ordinarily, from the foundry standpoint, the solid shrinkage is regarded as the linear contraction in cooling from solid metal at the freezing point to room temperature. The coefficient of expansion of the light aluminum alloys varies from about 0.000022 to 0.000027 per degree centigrade, while for the usual alloys the patternmaker's shrinkage is taken as 0.156 in. per foot.

The solidification shrinkage of substantially pure aluminum, on passing from the liquid state (density, 2.382) at 658.7 degrees Cent. to the solid state (density, 2.55) at the same temperature, is 6.6 per cent. The liquid shrinkage of substantially pure aluminum on cooling from 1000 degrees Cent. (density, 2.262) to 700 degrees Cent. (density, 2.371) is about 4.6 per cent. The solid shrinkage of aluminum

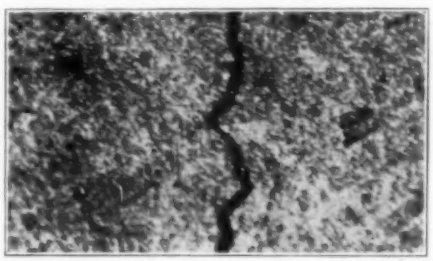


FIG. 2—CRACK IN 90:10 Al-Cu CASTING, UNPOLISHING—X 4.5

by calculation from the expansivity formula is 0.22 inches per foot, or 1.83 per cent. The total shrinkage (contraction in volume) of aluminum, or of any metal or alloy, on cooling from any temperature in the liquid state to any temperature in the solid state is the sum of the liquid shrinkage plus the solidification shrinkage plus the solid shrinkage.

Few data are available as to the contraction in volume of the various commercial aluminum alloys, but Edwards gives the contraction in volume of a 92:8 Al-Cu alloy from the beginning to the end of freezing, *i.e.*, over the temperature interval 630 to 540 degrees Cent. as about 7.0 per cent. The liquid shrinkage of this alloy in cooling from 1000 degrees Cent. (density, 2.434) to 700 degrees Cent. (density, 2.524) is about 3.5 per cent. The solid shrinkage from the freezing point (540 degrees Cent., where freezing is complete) to room temperature is taken as about 0.156 inches per foot, or 1.30 per cent.

Only a few data are available on the linear contraction of aluminum

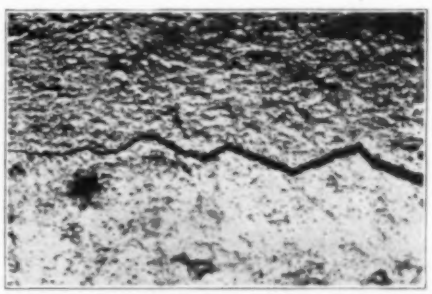


FIG. 3—CRACK IN 90 : 10 Al - Cu CASTING, UNPOLISHED—X 4.5

alloys on casting in sand molds: Tables 1 and 2 indicate the tendencies for different alloys. Table 1 gives the results of measurements made at the National Physical Laboratory, Teddington, England. A number of measurements have been made at the U. S. Bureau of Mines on the linear contraction of aluminum alloys in graphite molds; a summary of a few of the measurements is given in Table II.

Although the less the contraction in volume (or the less the linear contraction) the less likely is the alloy to crack; this is not an absolute criterion of the cracking tendency because certain alloys that may have a relatively small contraction in volume may be excessively weak at high temperatures. The 91:8:1 Al-Cu-Fe alloy has a matrially lower linear contraction than the 92:8 Al-Cu

FIG. 4—SAME AS FIG. 3, BUT POLISHED AND ETCHED WITH NaOH; OBLIQUE ILL.—X 6

alloy but it has greater strength at elevated temperatures; consequently it is less likely to crack on casting. As the 87:13 Al-Si alloy has a low linear contraction, certain complicated castings have been poured from it without the use of chills, when the same castings made in the 92:8 Al-Cu alloy required chills.

The fact that certain light aluminum alloys on casting are more likely to crack than others is well known; that is, the cracking tendency varies with the chemical composition of the alloys. As a general rule, the aluminum-zinc alloys are known to crack more readily than the aluminum-copper alloys, while some aluminum-copper zinc-alloys (such as 85:3:12 Al-Cu-Zn) crack less readily than the former. In general, the contraction in volume of the aluminum-zinc alloys is considerably greater than that of the aluminum-copper alloys; these alloys also are much weaker at high temperatures than the latter. On the other hand,

Paper presented at the meeting of the American Institute of Mining and Metallurgical Engineers, held in Rochester, N. Y., June 5 to 9. The author, Robert J. Anderson, is metallurgist, United States bureau of mines experimental station, Pittsburgh.

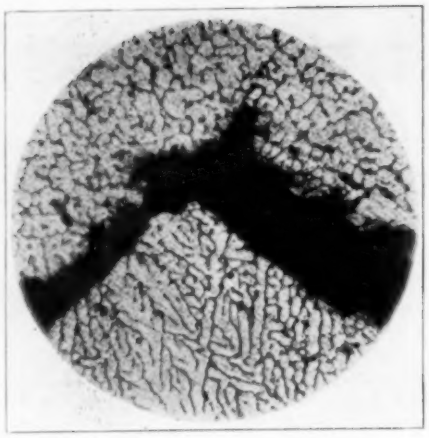


FIG. 5—SAME AS FIG. 4; ETCHED WITH NaOH—X 75

while the contracton in volume of some aluminum-copper-zinc alloys is less than that of some aluminum-copper alloys, the former are much weaker at high temperatures. The strength at high temperatures may be a more important factor than the contraction in volume, at least in the case of some alloys. Heterogeneity, due to segregation, is much more marked in some aluminum alloys than in others; this leads to planes of weakness that may give rise to actual cracks or to strain cracks. Consideration must be given to any possible contractions or expansions on passing through the solidification range or in cooling in the solid state.

Quality of Melting Charge

Some foundrymen claim that the 92:8 Al-Cu and related aluminum-copper alloys are more likely to crack when made up from all-primary materials, than when some foundry scrap is used in the charges. In other instances, it is claimed secondary aluminum and secondary aluminum-alloy pig are likely to give rise to cracks. It is also claimed that so-called brittle aluminum pig, which may or may not have cracks in the webs, will yield cracked castings. This question requires research; the results of tests made to date are not wholly conclusive. The question of impurities in aluminum pig and melting charges, more especially silicon and aluminum oxide, appears to merit investigation in its relation to cracks, but the available data in regard to this matter are meager.

Design of Castings

One of the most important factors that affect the occurance of cracks in aluminum-alloy castings is the design. As is well known, thick and thin sections in contiguity form a prolific source of cracks. If a rounded fillet is placed at the juncture of the thin and thick sections, the bad effects of the design will be overcome in part, and the section will be less likely to crack. It is generally necessary to chill heavy sections that are in contiguity with light ones so as to increase the rate of cooling of the former; an alternative is to feed with a riser.

Microscopic examination has shown that cracks may exist at the juncture of two sets of columnar crystals in aluminum alloys, and that foreign inclusions may be forced into such junctures as well as between any two given columnar crystals. Fig. 1 shows two fissures at the juncture of a set of thin and thick columnar crystals in a section of the 92:8 Al-Cu alloy.

Under the method of molding, there may be included ramming, gating, cores, risers, and chills. Of course, the sand should be tempered properly and it should not be too wet; wet sand may cause cracks and warping. The bottom boards under the flask should be placed correctly and the flask should be set evenly on the floor; otherwise strains will be set up in the mold.

Sand molds for aluminum alloys should be rammed lightly and evenly. If the sand is rammed too hard, the casting will be prevented from moving while contracting on cooling, thereby setting up strains and, at times, causing fractures in the casting. On the other hand, if the mold is rammed too lightly, there may be sudden collapsing of parts of the mold while the temperature of the alloy is immediately below that of final freezing. Strains set up by the collapse of the mold may be sufficient to cause cracking because the aluminum

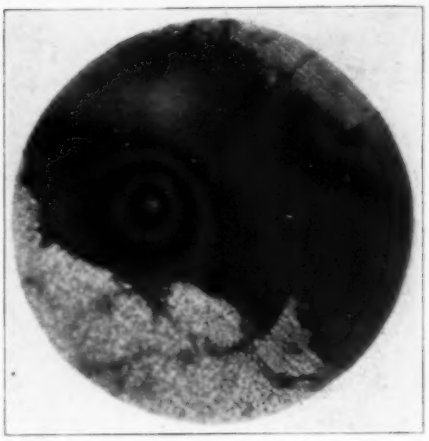


FIG. 6—SAME AS FIG. 4; ETCHED WITH NaOH—X 225

Table I

Linear Contraction of Aluminum Alloys in Sand Molds

Approximate Composition, Elements, Per Cent					Linear Contraction, Per Cent	Patternmakers Scale
Al*	Cu	Mn	Sn	Zn		
85.0	...	...	...	15.0	1.42	1/69
88.0	2.0	...	...	10.0	1.40	1/71
91.0	8.0	1.0	...	...	1.31	1/75
83.75	2.75	...	...	13.5	1.27	1/78
82.0	3.0	...	...	15.0	1.25	1/79
90.0	10.0	...	...	...	1.25	1/79
88.0	12.0	...	...	...	1.25	1/79
86.5	12.0	...	1.5	...	1.25	1/79
88.75	10.0	...	1.25	...	1.22	1/81
85.0	14.0	1.0	...	...	1.21	1/82
91.0	7.0	...	1.0	1.0	1.19	1/84

*Aluminum, difference.

FIG. 7—CRACK IN CRANKCASE

FIG. 8—DRAW IN SAMPLE FROM CRANKCASE; OPPOSITE SIDE OF FIG. 7

BARREL PATTERNS

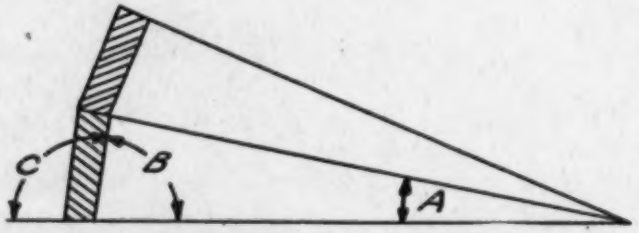
By R. R. McGowan

FORMULAE FOR DETERMINING STAVE ANGLES

$$\text{No. 1 Angle A} = \frac{\text{Degrees in a Circle}}{\text{Number of Staves}}$$

$$\text{No. 2 Angle B} = \frac{180 - A}{2} \text{ or } \frac{180 - \frac{360}{\text{No. of Staves}}}{2}$$

$$\text{No. 3 Angle C} = 180 - B \text{ or } 180 - \frac{180 - \frac{360}{\text{No. of Staves}}}{2}$$



SKETCH SHOWING STAVE ANGLES

TABLE CALCULATED FROM ABOVE FORMULAE

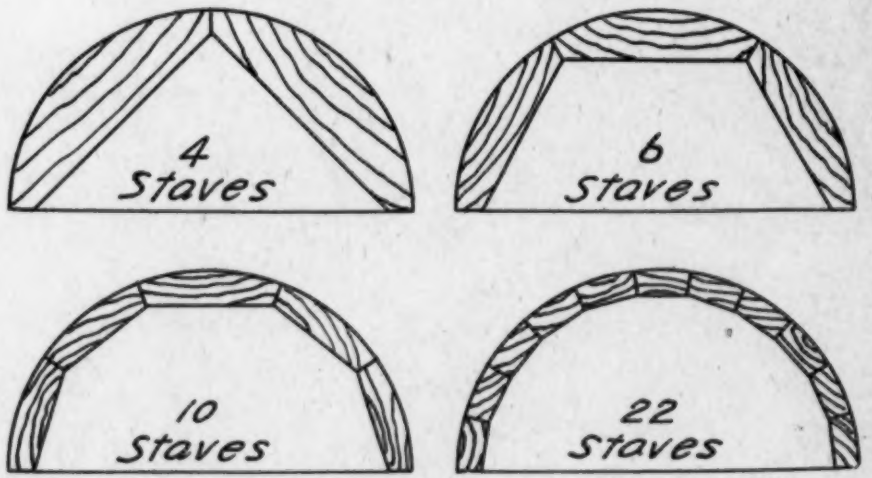
Number of Staves	Angle A Degrees	Angle B Degrees	Angle C Degrees
4	90	45	135
6	60	60	120
8	45	67-1/2	112-1/2
10	36	72	108
12	30	75	105
14	25-5/7	77-1/7	102-6/7
16	22-1/2	78-3/4	101-1/4
18	20	80	100
20	18	81	99
22	16-4/11	81-9/11	98-2/11
24	15	82-1/2	97-1/2
26	13-11/13	83-1/13	96-12/13
28	12-6/7	83-4/7	96-3/7
30	12	84	96
32	11-1/4	84-3/8	95-5/8
34	10-10/17	84-12/17	95-5/17
36	10	85	95
38	9-9/19	85-5/19	94-14/19

(*Concluded on Data Sheet No.* 442)

BARREL PATTERNS

By R. R. McGowan

(*Concluded from Data Sheet No.* 441)



SKETCH SHOWING HALF PATTERNS OF DIFFERENT NUMBERS OF STAVES

EXAMPLES SHOWING APPLICATION OF FORMULAE

Example No. 1. Find the Angle A for a 10 Stave Barrel Pattern.

By Formula No. 1. $\frac{\text{Degrees in a Circle}}{\text{Number of Staves}} = \text{Angle A.}$ Therefore $\frac{360}{10} = 36°$

Example No. 2. Find the Angle B for a 10 Stave Barrel Pattern.

By Formula No. 2. $\frac{180 - A}{2} = \text{Angle B.}$ Therefore $\frac{180 - 36}{2} = 72°$

Example No. 3. Find the Angle C for a 10 Stave Barrel Pattern.

By Formula No. 3. $180 - B = \text{Angle C.}$ Therefore $180 - 72 = 108°$

THE FOUNDRY DATA SHEET, AUGUST 15, 1922
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections 5 x 7 inches, and may be readily bound in note book form.

Table II

Linear Contraction of Aluminum Alloys in Graphite Molds*

Approximate Composition, Elements, Per Cent								Linear Contraction, Per cent	Patternmakers Scale
Al†	Cu	Fe	Mn	Ni	Si	Sn	Zn		
100	..	..	..	..	..	..	..	1.74	1/57
92	8	..	..	..	..	..	..	1.40	1/71
90	10	..	..	..	..	..	..	1.25	1/79
88	12	..	..	..	..	..	..	1.20	1/83
91	8	1	..	..	..	..	..	1.24	1/81
95	3	..	2	..	..	..	..	1.52	1/66
90	8	..	..	2	..	..	..	1.28	1/78
87	..	..	..	..	13	..	..	1.17	1/85
90	8	..	..	..	..	2	..	1.35	1/74
85	3	..	..	..	..	..	12	1.20	1/83

*These figures refer to bars poured at 800 degrees Cent.; the actual linear contraction varies with the pouring temperature.

†Aluminum, difference.

alloys in general are quite hot short. The sand may be rammed loosely around the gates to prevent hanging of the casting in the mold. Thin sections should be rammed more lightly than thick sections. In general the hardness of ramming is an item governed principally by

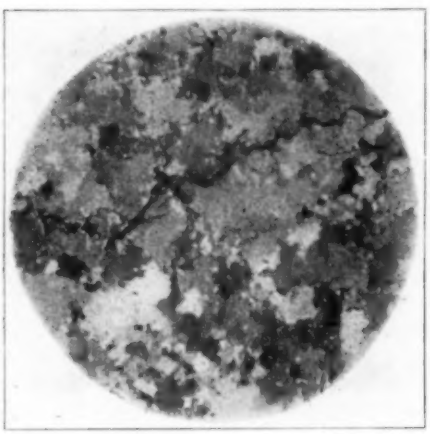


FIG. 9—CRACK SHOWN IN FIG. 7; MICROGRAPH, ETCHED WITH NaOH; OBLIQUE ILL.—X 4

experience, but the amount of ramming can be determined with fair accuracy if power molding machines are used.

Theoretically, a casting should be so gated that when the mold cavity is full of metal, the length of the path over which the metal has traveled will have been such that the heavy sections will be filled with colder metal than the light sections. Mechanical difficulties make such gating impracticable in most commercial castings. The sprue and header should be made heavy and of such size that they will not solidify prior to the casting, and fillets of ample size should be employed where the gate is attached to the casting. If the gate solidifies prior to the casting, it will draw from the casting and hence be likely to cause cracks. Where cracks can be traced to the method of gating, an alteration of this may often effect their elimination. Usually, that part of the casting nearest to the gate is the last to solidify.

Cracks will always be less with green-sand cores than with dry-sand cores, although if higher pouring temperature must accompany the use of green-sand cores, this would tend to increase cracks. The dry-sand core is unyielding as a rule, unless the binder, like resin, will soften readily at the temperature set up on pouring.

Speaking generally, so far as chills are related to the occurance of cracks, this defect has been attributed to lack of chills where chills are necessary; chills placed in the wrong position in the mold or cores; too heavy chills; and too light chills. Where a thin and a thick section are in contiguity the function of the chill is to equalize the rates of solidification in the two sections by increasing the rate of freezing of the heavy section. Chills should vary in power, depending on their position in the mold and on the size of the section to be chilled.

The number of risers required for a casting depends on the area of the surface at the top of the casting, among other things, and on the relation of the area of the upper surface to that of the lower surface. Further the number of risers required depends on the number of sections to be fed, and their size depends on the size of the sections. Too many risers should not be used as they cause the casting to be anchored in the mold and prevent it from moving freely when shrinking.

Irrespective of the type of furnace, heating to too high a temperature should be avoided at all times, for metals and alloys dissolve more gases with increasing temperatures. On the basis that the greater part of the dissolved gas is carried in the amorphous cement at the grain boundaries in the solid state, it might be expected that the forcing of gas into the grain boundaries would give rise to strains and weakness at these places, and consequently aggravate the tendency to crack.

Good castings have been made from alloys melted in all types of furnaces. In considering the effect of the furnace

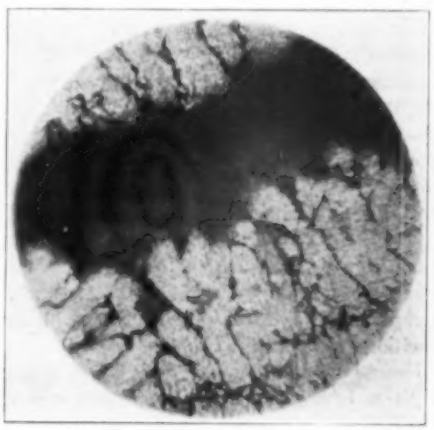


FIG. 10—SAME AS FIG. 9; ETCHED WITH NaOH—X 225

used, it is necessary to know the constitution of the furnace atmosphere. Thus, melting at a relatively high temperature in an atmosphere containing much free oxygen (as in most reverberatory and open-flame furnaces) would give rise to more aluminum oxide in the alloy than melting at the same temperature in an atmosphere containing little oxygen but much carbon dioxide. Occluded dross particles (and perhaps also dissolved aluminum oxide) will give rise to weak metal, which would tend to crack more readily than metal free from occlusions. The melting temperature is governed quite largely by the type of furnace employed; charges are generally heated to higher temperatures in furnaces of the open-flame type than in iron-pot furnaces. Further, the type of furnace employed determines to some extent the amount of impurities present in the resultant alloy. When the 92:8 Al-Cu alloy is melted in iron-pot furnaces, the iron content may be from 1.0 to 2.0 per cent., but if melted in crucibles or against refactory

Table III

Tensile Strength of Two Aluminum Alloys

Temperature, Degrees Cent.	Values for 92:8 Al-Cu Alloy: Ultimate Strength, Pounds per Square Inch	Elongation in 2 Inches, Per Cent	Reduction in Area, Per Cent	Values for 90.25:8:1.75 Al-Cu-Fe Alloy: Ultimate Strength, Pounds per Square Inch	Elongation in 2 Inches, Per Cent	Reduction in Area, Per Cent
100	21,800	1.25	0.8	25,000	0.5	1.6
200	18,500	3.00	2.0	22,000	1.0	2.0
300	17,500	6.00	4.0	19,900	2.0	3.3
400	9,900	15.5	17.7	10,200	6.5	12.3
500	3,000	24.2	38.8	3,900	22.5	30.3

Values given are the mean of three determinations—Sand-cast bars.

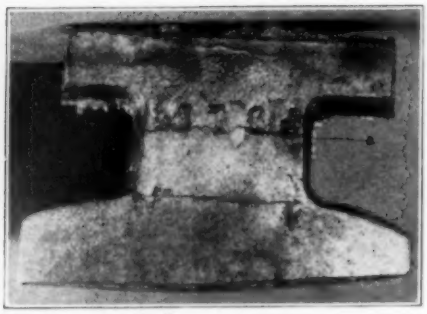


FIG. 11—CRACK IN SPECIAL CASTING; ABOUT 1/3 ACTUAL SIZE

brick linings, it will be about 0.40 to 0.75 per cent. In the same way, the silicon content of alloys melted in crucibles or against siliceous linings will be much higher than when melted in iron pots. Other things being equal, therefore, it would be expected that the 92:8 Al-Cu alloy would be less likely to crack, when melted in iron pots than in other types of furnaces.

Effect of Pouring Temperature

Cracks in aluminum-alloy castings have been attributed to too high and too low pouring temperatures; but opinion is variable as to what should be regarded as the correct pouring temperature for the different commercial alloys. An alloy poured at a high temperature will have a considerably greater total liquid and solidification shrinkage than one poured at a low temperature, since the total shrinkage is a function of the pouring temperature. In general, a high pouring temperature (which presupposes a high melting temperature) may be expected to cause cracking, which would not occur with a lower pouring temperature under otherwise similar conditions. A too low pouring temperature has been claimed to be the cause of cracking, but it is difficult to see how this can be so.

The presence of foreign inclusions in cast aluminum alloys, such as dross particles, so-called hard spots, and other included matter has been associated with cracking. As is explained later, cracks in both eutectiferous and solid-solution alloys have a strong tendency to be intergranular, and where foreign included matter is located at grain boundaries (or elsewhere), it tends to weaken the alloy and aggravate any condition which may lead to cracks.

While cracks have been found in aluminum-alloy castings quite free from foreign inclusions, they are found more often in unsound and dirty castings. Inclusions in the alloys may be avoided by cleanliness in charging and melting practice, and much of the trouble traceable to cracks arising from this cause can be eliminated.

The relative tendency of different aluminum alloys to crack on casting may be determined by the hot shortness tester, devised by Gillett and Skillman.*

So far as is known, the greater the ultimate strength of any alloy at temperatures approaching the melting point, and the greater the elongation, the less

FIG. 13—CRACK IN CRANKCASE; ETCHED WITH NaOH; OBLIQUE ILL.—X 8

is the tendency to crack. The ultimate strength and elongation in the cold cannot be taken as criteria of this tendency, nor can either of these properties be considered alone. Thus, certain aluminum-zinc alloys have enormous elongation at elevated temperatures but low strength. These alloys crack more readily than some aluminum-copper alloys that have only moderate elongation at high temperatures, but still fair strength.

On the whole, the elongation may be regarded as a poor measure of the cracking tendency and, as determined by the ordinary tensile strength at high temperatures, it will not reveal necessarily the presence of brittleness, even when present in high degree. Extreme ductility under gradually and steadily applied tension may be accompanied by brittleness to sudden strains or shocks.

The addition of iron, nickel, or manganese in relatively small percentages to certain light aluminum-copper alloys increases the strength markedly at elevated temperatures; Table III shows the effect or iron on the 92:8 Al-Cu alloy. The addition of 1 to 3 per cent nickel to aluminum-copper alloys containing 8 to

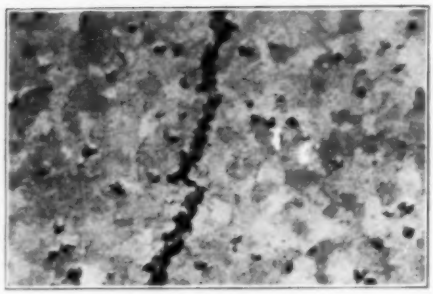


FIG. 12—PART OF CRACK SHOWN IN FIG. 11; ETCHED WITH NaOH; OBLIQUE ILL.—X 4

12 per cent copper markedly improves the strength both in the cold and at elevated temperatures. The alloy 86:12:2 Al-Cu-Ni has an ultimate strength of about 20,000 lb. per sq. in. at 250 degrees Cent. which is about the same as that of the alloy 85:14:1 Al-Cu-Mn. This may be compared with 14,000 lb. for the alloy 88:12 Al-Cu and with 13,000 lb. for the alloy 91:7:1:1: Al-Cu-Sn-Zn, both at 250 degrees Cent.

To sum up; alloys that have fairly good strength at high temperatures are less likely to crack than those which are weak, but this property must be correlated with the contraction in volume. Thus, although the strength of one alloy at, say 500 degrees Cent. is considerably greater than that of another alloy, but the contraction in volume is substantially greater, the tendency to crack in the first alloy might be much greater than that in the second alloy.

The metallography of cracks may be discussed conveniently by reference to several typical cases. The cases here described are a few from a large number of samples submitted to the U. S. bureau of mines.

Cracked Housing

The first case is the occurrence of cracks in certain lots of vacuum-cleaner housings made in the 90:10 Al-Cu alloy. The charge consisted of all-primary aluminum pig plus 50:50 Al-Cu alloy. When the job was first put into production, the castings were found to be cracked

*A. B. Norton: A Hot Shortness Testing Machine for Aluminum Alloys, *Trans.* Am. Inst. of Metals (1914), 8, 124-126.

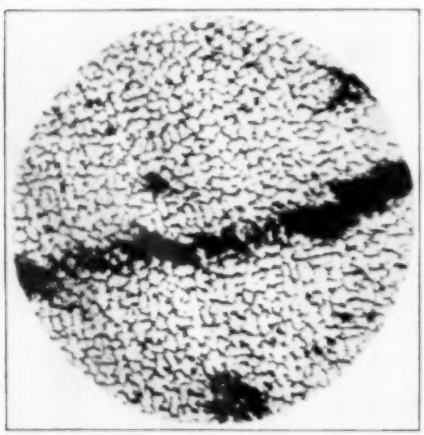


FIG. 14—TENUOUS INTERNAL CRACK; ETCHED WITH NaOH—X 35

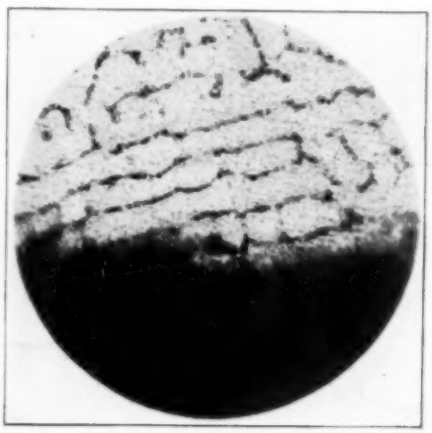


FIG. 15—EDGE OF CRACK IN FIG. 13; ETCHED WITH NaOH—X 150

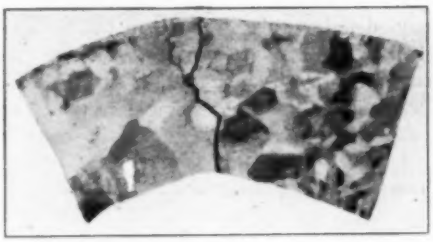


FIG. 16—INTERGRANULAR CRACK IN CHILL-CAST 92:8 Al-Cu ALLOY; ETCHED WITH NaOH; OBLIQUE ILL.—X ABOUT 2

badly, but at the end of the third or fourth day, after the foundry scrap, defectives, gates, etc., were in circulation, cracking ceased. The iron content of the alloy had increased materially after repeated remeltings (iron-pot practice employed), so the cracks were attributed to lack of iron in the alloy. Figs. 2 and 3 show the appearance of two cracks in a housing, while Fig. 4 shows the intergranular character of the crack in Fig. 3—the crack follows the boundaries of the large grains. Fig. 5 shows the appearance of part of the crack in Fig. 4, while Fig. 6 indicates a tendency for the crack to follow along the eutectic boundaries of the small grains.

The second case is a sample taken in the production of an eight-cylinder crankcase for a standard motor car made with the 92:8 Al-Cu alloy. Fig. 7 shows fine crack *a*, and Fig. 8 shows a draw *b* on the opposite side at the juncture of a thin and a thick section. Fig. 9 shows that the tendency of the crack is to be intergranular largely, although parts of it appeared to be intergranular also. Fig. 10 shows the microscopic appearance of the crack at one point.

Fig. 11 shows the appearance of the crack *a* in a piece cut from the top of a specialty casting made of 92:8 Al-Cu alloy, while Fig. 12 shows a part of the crack in a polished and etched section. This crack did not follow the grain boundaries and the path of the crack was quite indiscriminate, being both intergranular and intragranular, with no particular tendency toward any particular path. This particular crack was attributed to hanging in the mold, because of too hard ramming of the sand around the pouring gate.

A sample taken from a crankcase for a twelve-cylinder motor, made of the 91:8:1 Al-Cu-Fe alloy is shown in Fig. 13. No definite cause could be ascribed for this particular crack. Fig. 14 shows a tenuous crack in the interior of the section, corresponding to the lines in Fig. 13. The gross grain size of the alloy was large, and the crack had a fairly pronounced tendency to follow an intergranular path. Fig. 15 shows the edge of the crack in Fig. 13 at higher magnification; at this point, the crack was fairly smooth and ran parallel to the eutectic stringers.

Some Miscellaneous Cases

A number of experiments have been made to produce cracks at will in various alloys under definite conditions, but principally by pouring an annular-ring casting in a chill mold around a metal core. The complete results of these experiments are not yet in hand, but a few of the results show the tendency toward intergranular cracking. Although a crude method for determining the cracking tendency in different alloys, pouring a casting in the form of an annular ring is one method of determining the die-casting qualities of aluminum alloys. It has been shown by preliminary experiments that the tendency to crack under this test varies with the alloy used and with the pouring temperature for a given annular-ring mold.

Fig. 16 shows an intergranular crack in the 92:8 Al-Cu alloy poured in a small annular-ring mold at 900 degrees Cent. Fig. 17 is a macrograph of a similar casting poured in the 85:3:12 Al-Cu-Zn alloy at 870 degrees Cent.; the intergranular path of the crack is quite plainly shown. Figs. 18 and 19 are micrographs of two points in Fig. 17 showing that the path of fissure follows the boundaries of the large grains of the alloy, as indicated by the differential etching.

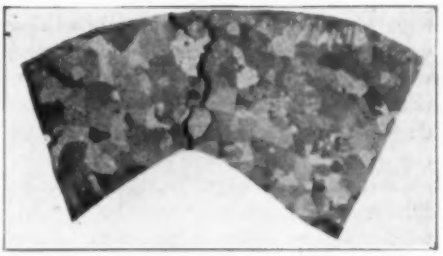


FIG. 17—INTERGRANULAR CRACK IN CHILL-CAST 85:3:12, Al-Cu-Zn ALLOY; WITH ETCHED NaOH; OBLIQUE ILL.—X ABOUT 2

In considering the occurrence of cracks in aluminum-alloy castings, the question naturally arises. Is the crack intergranular or intragranular? On theoretical grounds, it would be expected that a crack caused by stresses at high temperatures would follow the grain boundaries both in eutectiferous and in solid-solution alloys. While it is not necessary here to deal at length with the freezing of alloys of different types, in the case of an eutectiferous alloy a sufficient stress at high temperatures will cause fracture through the eutectic areas. At a sufficiently high temperature, the eutectic will be liquid when the matrix of the alloy is still solid, and under stress the fracture will occur through the weak

Table IV

Tensile Properties of Aluminum-Zinc Alloys

Temperature, Degrees Cent.	Yield Point, Pounds per Square Inch	Ultimate Strength, Pounds per Square Inch	Elongation, Per Cent
	Values for 80:20 Al-Zn alloy		
100	22,800	28,040	18.0
250	10,380	10,380	28.5
300	7,480	7,480	28.0
400	1,880	1,880	92.0
500	780	780	92.5
595	700	700	130.0
	Values for 74:26 Al-Zn alloy		
150	26,260	35,280	15.5
200	21,140	21,140	11.5
250	13,500	13,500	21.5
300	8,160	8,160	28.5
400	2,680	2,680	48.0

Based on Rosenhain and Archbutt.

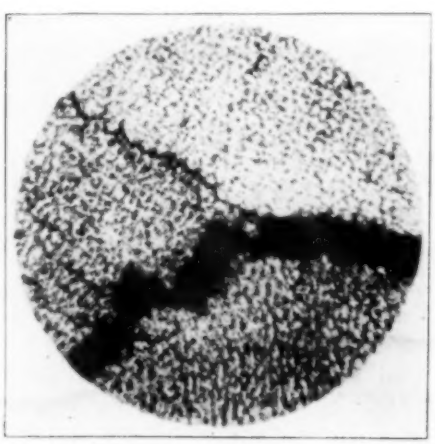


FIG. 18—CRACK SHOWN IN FIG. 17; WITH ETCHED NaOH—X 75

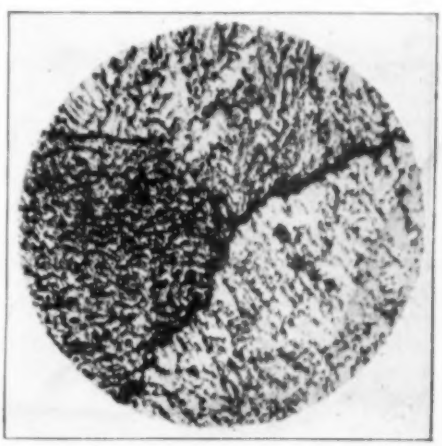


FIG. 19—SAME AS FIG. 18, BUT AT ANOTHER PLACE; ETCHED WITH NaOH—X 75

liquid. Since eutectics are brittle, it would be expected that the fracture would take place through them rather than through the matrix owing to contraction or to stresses at lower temperatures.

In the case of pure metals and solid-solution alloys, cracks would be expected to follow the grain boundaries, *i.e.*, go through the amorphous cement, in the case of stresses at high temperatures, *viz.*, at temperatures exceeding the equi-cohesive temperature. At lower temperatures, the fracture would be intergranular because the amorphous metal is stronger than the crystalline; but above the equi-cohesive temperature the amorphous phase is weaker than the crystalline phase, and consequently cracks due to solidification shrinkage will be intergranular. While at the ordinary temperature, the amorphous cement may be regarded as hardening and strengthening the grain boundaries (and consequently the mass of metal), at a sufficiently high temperature the strength of the cement is less than that of the grains of metal. Where a crack is found assuming an indiscriminate path, it may be due to rupture at the equi-cohesive temperature, *i.e.*, at that temperature where the resistance of the cement is the same as that of the grains.

It may be said that in the case of cracks originating from stresses at a low temperature, cracking will be less likely to occur in fine grained metals than in coarse-grained ones. Fine-grained metals and alloys consist of a greater proportion of the amorphous phase and a lesser proportion of the crystalline phase than do coarse-grained ones. The former are consequently stronger and, in general, less likely to crack. On the other hand, the cracking tendency will be greater in fine-grained metals than in coarse-grained in the case of stresses at high temperatures; *i.e.*, above the equi-cohesive temperature, because the amorphous phase is weaker than the crystalline phase at the higher temperatures.

Some of the illustrations show that the grain size was quite large and that the cracks passed along the boundaries of the large grains. In the eutectiferous 92:8 Al-Cu alloy, it is not to be supposed that the eutectic is segregated entirely at the boundaries of the large (macroscopic) grains, but each of the large grains will be found, on microscopic examination, to consist of a number of smaller grains surrounded by the eutectic. A crack may pass through a large grain and still be intergranular with respect to the small grains within the large grains (see Figs. 9 and 10).

The contraction of volume is a fixed constant for a given alloy, so alloys that have an excessively large contraction in volume should be avoided for the production of complicated castings or those of intricate design; for instance, large and complicated crankcases. Of course, for some simple castings, alloys with high shrinkage may be employed satisfactorily. The contraction in volume may be controlled, within limits, by the correct use of risers and chills, so that a given alloy is not necessarily unsuitable for use in complicated castings simply because it has a high shrinkage.

Both the contraction in volume and the physical properties at high temperatures are dependent on the composition of the alloys, and alloys should be chosen, on the basis of adequate test data, that properly fulfill the requirements. The quality of the melting charge should be controlled by chemical analysis; much of the difficulty experienced with cracking comes from inadequate control of the melting stock.

Castings should be designed correctly, from both the foundry and the engineering standpoints. So long as complicated and intricately designed castings must be made, cracks cannot be wholly eliminated. From the foundry standpoint, the simpler the design, the less difficulty experienced in production; it would seem as though many castings are made needlessly intricate. Methods of molding and the use of chills and risers are variable factors that depend on the casting to be made; it is not possible to formulate any definite rules for them. The expedient of experimental molding, as suggested by Traphagen*, is valuable in determining the most suitable method for molding a given casting, with particular reference to gating, risers, and chills. Too hard ramming should be avoided, and the required hardness of molds may be determined experimentally where experience is an insufficient guide. The gates should be of ample size and attached correctly to the casting; the use of horn gates, where possible, is recommended for they permit the metal to enter the mold with the least disturbance.

Much of the difficulty experienced with cracking is traceable to the cores and to faulty core-room practice; too much emphasis cannot be placed on the necessity of using cores of the correct hardness.

Many cracked castings could have been saved if they had been chilled properly; also, if the risers had been correctly placed. While many simple castings do not require risers, they must be used on most large and complicated castings so that certain parts of the castings may be fed with liquid metal.

The melting temperatures should be low; overheating in the furnace should be avoided. Open-flame furnaces should be run with a non-oxidizing atmosphere in order to avoid the formation of much aluminum oxide, and consequently occluded dross in the alloy. Skimming should be adequately and carefully done and the melting practice should be conducted as cleanly as possible. Foundry-floor sweepings should not be charged into the furnaces unless sieved, and foreign materials should be kept out of the furnace charges. The pouring temperatures should be as low as is consistent with filling the mold readily with metal; high pouring temperatures should be avoided. This presupposes pyrometric control.

*H. Traphagen: Value of the Scrap Pile, paper before the Am. Foundrymen's Assn., Philadelphia meeting, September, 1919.

How and Why in Brass Founding

By Charles Vickers

Zinc Injurious to Babbitt

We have made babbitt from scrap metal and the customers complain of blow holes, or small pin holes, in the babbitt after it has been applied and turned off. Also some small spots of dross appear. The analysis is about as follows: Copper, 0.06 per cent; tin, 4.58 per cent; lead, 83.30 per cent; zinc, 0.04 per cent; antimony, 9.72 per cent; iron, 0.03 per cent; aluminum, trace; arsenic, 0.13 per cent. Can you suggest the element or elements that are likely causing the trouble?

The element that is likely causing the trouble is the zinc; this element is notorious as a dross former in such alloys, and it is not easily eliminated. Steam is blown through the molten metal and sulphur is added to remove the zinc. In some foundries potatoes are submerged and held under the surface of the babbitt. The potatoes generate steam which bubbles up through

the metal, and the zinc forms a dross on the surface. It then can be removed by means of a perforated ladle. The addition of a little sal ammoniac to the surface of the molten metal, with continued skimming, will in time, remove all the zinc. In pouring the bearings the addition of a small piece of rosin to the metal in the ladle, just before pouring, will clarify the babbitt and assist it to run more fluidly.

The alloy will be improved by raising the antimony to 15 per cent at the expense of the lead, as it will then conform in analysis to well known and standard antifriction metal.

Swab Causes Holes when Used Too Freely

We are sending for your inspection, two small red brass castings; one in the rough, and one machined, so you will understand how the castings are gated and how they appear when machined, with particular reference to the series of small holes that are uncovered when the skin is cut away. The casting resembles the hub and a segment of a small wheel, and the holes are confined to what would be the tread of the wheel right next the cope surface. The alloy consists of copper, 87 per cent; tin, 5.8 per cent; zinc, 3.5 per cent; lead 3.7 per cent. The metal is melted in graphite crucibles in a coke-fired pit furnace, and virgin metals are used, the white metals being added as a hardener, after the copper has melted. As a deoxidizer we are using stick phosphorus, also phosphor tin and phosphor copper.

The holes on the edge of the curved part of the casting are caused by the too liberal use of water when swabbing the patterns preparatory to withdrawing them from the mold. We suggest a more sparing use of the swab, or the use of kerosine oil instead of water on this part of the mold. Sometimes dusting parting material over the patterns after they have been swabbed, followed by blowing it off again will dry the sand sufficiently to permit the liquid metal to rest quietly instead of sputtering and entrapping steam, which produces the holes.

There appears to be nothing wrong with the metal; your's is a purely molding difficulty. If the metal was aerated in the furnace, the holes would appear in other parts as well as in the particular place where now found. The section where the holes are found, is the place where naturally the first swab full of water would be applied by the molder, and it is simply getting more than its share of water.

Excess Zinc Will Ruin Manganese Bronze

Return gates and scrap from our manganese bronze castings amounts to a considerable item, but when we use it to make other manganese bronze castings we find that the twice melted metal is rotten and has no strength. How can we revive the metal before using it the second time?

Nothing that can be added will convert rotten manganese bronze into good metal. If the metal shows good tensile and elongation on the first melt, then something is radically wrong with the manner in which it is handled the second time. The remelted gates and scrap metal should produce castings on the second melt just as good as on the first and some times better, because some of the tensile should be exchanged for elongation. Are you adding zinc to the remelt? If so, how much? Excess zinc will make the metal brittle, even in quantities as low as 3 per cent. Probably the melter *guesses* that a certain proportion of the zinc has volatilized during the first melt and to compensate for this condition, adds good measure on the second melt and the result is brittle metal. A chemical analysis is necessary to determine the amount of zinc, if any, to be added to the remelt. The ingot should be analyzed, also the casting poured from the first melt of the ingot with special reference to the zinc content and after a number of analyses have been made it will be possible to determine the loss and the proper addition can be made to the remelt. Melting methods differ widely and it never is safe to gage zinc losses by some persons experience. An analysis of the *rotten* metal will uncover the cause of the condition.

Blister Forms on Aluminum Castings

We are making aluminum steering-wheel spiders and frequently find blisters, which when filed off have a small hole underneath. We gate the casting on top of the boss using a drop gate that straddles the core. The holes come at various places at different times, on both the cope and the drag. We use zinc chloride flux on No. 12 aluminum alloy without scrap, and melt in coke-fired crucible furnaces.

Examination of the casting shows that the parts farthest removed from the gate are clean and sound, the dross and defects are all concentrated around the part where the casting was gated. Aluminum is a drossy, sluggish metal, and if it is dropped into any comparatively massive section like this boss, the result will be more or less dross. As the castings fail to come good with this method of gating, it is time to make a change. One suggestion is to use a small horn gate under the hub and to connect the horn gate to a runner long enough to bring the sprue in line with the ends of the arms. This would cause the aluminum to run up hill to the hub, then flow into the casting. To avoid shrinkage the hub would either have to be chilled or fed with risers. The effect of a thin, broad gate at the end of one of the arms could also be tried. If the metal can be flowed in quietly, there will be no dross. Also if it is made to travel some distance the little particles of chloride that cause the blisters will be left on the way.

Die Casting Alloy

We should like to have the formula for a strong die-casting alloy suitable for the manufacture of small gears for a hand power mixer.

Aluminum bronze is an alloy suitable for gearing and is one that is die-cast on a large scale. In addition to spur and bevel gearing it has been used for certain kinds of worm gearing, die-cast almost to finished size in quantity production. A suitable alloy follows:

Aluminum Bronze

	Per cent
Copper	89.00
Aluminum	10.00
Iron	1.00

Add the iron in the form of tinplate clippings to the molten copper, then follow with the aluminum.

To Harden and Deoxidize Nickel Alloys

We are making nickel alloys of approximately copper 48 to 50 per cent; nickel 23 to 25 per cent; zinc 25 per cent. We would like to know if 2 per cent lead will soften this mixture, also what will make it harder and what to use for a deoxidizer.

Lead frequently is added to improve the machining qualities of nickel copper alloys. The alloys can be hardened by the addition of tin in small amount. It would be advisable to try about 1 per cent and cautiously increase as necessary. If stiffness is required, iron should be added in the shape of tin plate scrap, from 0.5 to 1.5 per cent iron can be experimented with until the correct degree of stiffness is obtained. Iron will whiten the alloy as well as stiffen it, but care must be exercised to add no more than the metal can take up, otherwise it will segregate in the shape of intensely hard nodules. Manganese copper is a deoxidizer frequently used with copper-nickel alloys. From 2 to 4 ounces per 100 pounds of alloy should suffice.

Making Malleable Castings-III

Tests Show Effect of Size of Gates in Distribution of Metal—Small Percentages of Chromium Shown To Have Marked Influence on Malleable Iron—Causes of Picture Frame Structure

BY ENRIQUE TOUCEDA

THE AUTHOR believes losses due to misruns and defective casting can be minimized through a study similar to the one he has undertaken, and which he believes is new. Some years ago the author was called in consultation in connection with a heavy foundry loss on certain sizes of piston rings. The rings were nested and gated together and poured in multiple molds. On analyzing the situation it was found that the loss was confined mostly to two sizes. The manner in which the problem was attacked was to take five single molds and short-pour them, that is pour a small amount of iron in the first mold, a little more in the second, a little more in the third, and so on to the fifth. In this manner the travel of the iron could be followed exactly. Briefly, the problem was solved by a change in the gates and runners in a manner that was contrary to the precepts that were heretofore considered orthodox. To conserve space, and because members are as fully able to analyze the situation as is the author, illustrations, Figs, 5, 6, 7, 8 and 9, are submitted without comment. These show some interesting examples of what short-pouring will disclose. In the case of all of these tests the molds were carefully levelled in two directions before the molten metal was poured into them. Lack of time has prevented the author securing such patterns as might have illustrated in a more exaggerated manner what he has attempted to set forth, while also he regrets the fact that he was unable to secure photographs of short-poured castings of a larger and more complicated design; but he believes that, in spite of this, the cases he is submitting to show the value of the information that can be obtained from a study of this character are sufficient. These experiments showed vital necessity of having the gate leading to all patterns on both sides of the contral runner exactly of the same shape and area as far as each pair is concerned; the area of the gates of each pair changed in accordance with what is disclosed by the short-pouring test, and the runners so tapered that the flow of metal will be more evenly distributed to each individual pattern in the flask, to the end that each one will be taking the metal as rapidly as the other. The casting shown in Fig. 10 is an eloquent testimonial of the length to which the founder is willing to go in his effort to insure the integrity of the casting. In this case the risers weigh more than the casting, but in addition to this expedient permission was obtained to place a strap on the casting shown at *A*, leading from the gate of each of the four heads upward towards the fillet, whereby a wide channel, for the metal to reach the top of the casting, is assured. In this manner the formation of a shrink at the fillet, where the smallest diameter swells gradually into the larger one, is prevented. Even with the precautions referred to a light shrink will be found occasionally in the section directly opposite a sharp corner. If permission could be obtained to round off this corner it would result in the disappearance of the shrink. In taking on new work the founder should not only experiment with the pattern until he has satisfied himself through the breaking up of the hard-iron castings, that shrink is absent and that he has ascertained the best method of gating and heading the casting, but after he has finally arrived at this decision he should anneal some of the castings in order to confirm this conclusion. Slight porosity is difficult to discover in a fracture of hard-iron, and it oftentimes happens that upon breaking up the annealed casting, which in its hard condition was supposed to be perfectly sound, it is found to contain some shrink. It might be well to note that in the author's experiments on shrink he has found that whether the iron was poured hot, medium, or fairly dull can be told by the color of the shrink. When poured very hot it is black, when poured at medium temperature it is dark grey, while the shrink resulting from metal poured fairly dull is light colored.

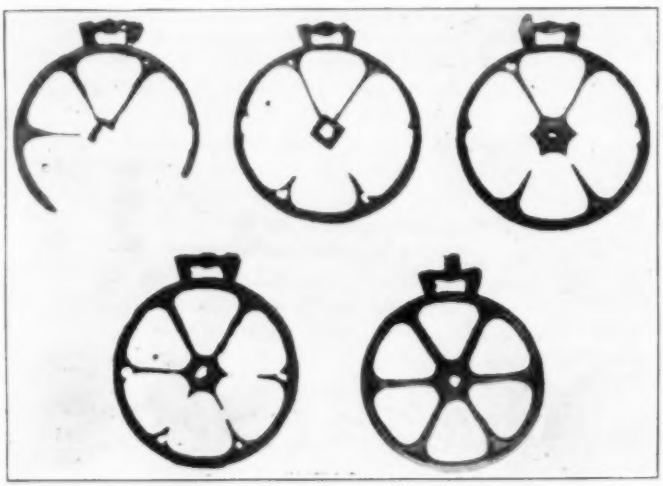


FIG. 5—WHEELS MADE BY POURING LIMITED AMOUNTS OF METAL INTO THE MOLD

What are the permissible limits for the various elements in the hard-iron is a question the author has been asked with frequency. Owing to the inter-relations of these elements the answer on its face appears to be complicated. While admitting the complexity of this inter-relation, actually, as far as practical work is concerned, there exists little reason why this fact need necessarily complicate the proposition. As previously set forth, with all other elements balanced a silicon content of 0.90 per cent in the hard iron yields desirable properties, for when heat treated it is resolved into a silico-ferrite matrix that, considered alone, is strong and ductile and of splendid machinability.

It has been established that the strength and ductility of this matrix is weakened by high total carbon, and that improvement takes place as carbon is lowered. The limit to which this safely can be carried without detriment to the fluidity and life of the molten metal, or increasing the tendency of the castings to crack or check on cooling to an objectionable extent, may be assumed to be approximately 2.35 per cent. The phosphorus appears to be in no sense detrimental up to 0.20 per cent. Inasmuch as no difficulty exists, nor is any expense attached to the adjustment of these three elements at these percentages, they can be elim-

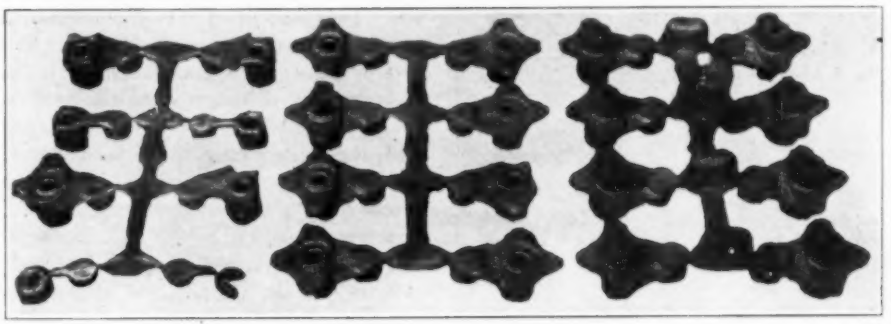


FIG. 6—THE LOWER CASTINGS ON THE LEFT WERE NOT AS WELL SUPPLIED WITH METAL AS THE OTHERS

inated from the problem and the disturbing elements considered to be sulphur and manganese only so far as these five elements are concerned. While it is not difficult to purchase low-sulphur pig and fairly low-sulphur scrap, it is getting increasingly difficult to secure low-sulphur fuel. Also in some localities it is rather difficult to purchase pig with a manganese as low as is desirable.

The question, then, really resolves itself into what are the permissible limits for the sulphur and manganese. While it is generally conceded that these elements should be present in atomic proportion to form manganese sulphide, the author has seen many instances in which the product was excellent where this was not the case. Based upon data obtained from the testing of many test bars, the author would state that with a sulphur content between the limits of 0.05 and 0.08 per cent it is safe to use a manganese content between the limits of 0.20 and 0.30 per cent, with the recritic rim and normally-structured core a partition ring of pearlite. Just why low silicon-manganese mixture will produce an iron having this tendency, and just why a high sulphur iron with insufficient manganese will do the same, the author does not know; but he does know that such is the case, and that when the metal is in this condition not only is the material hard to machine but that probably it will fail in service. In the absence of a decarbonized surface ring it does not appear possible to obtain a true frame, while, on the other hand, the presence of a decarbonized surface rim does not appear to act to produce a frame except under certain conditions which will be touched upon. The conclusions that follow may be correct, and they may not. It is not possible in regular practice to heat an ordinary ferrous metal in a heating furnace or annealing oven atmosphere without decarbonizing the surface to a certain depth. The same thing takes place when a gray-iron, a hard-iron, or a steel casting is stripped from the sand and exposed to the air while still red hot. This is true also to some extent even if they are not stripped at that temperature, for, as there is air in the mold, some decarbonization will take place on that account under all conditions.

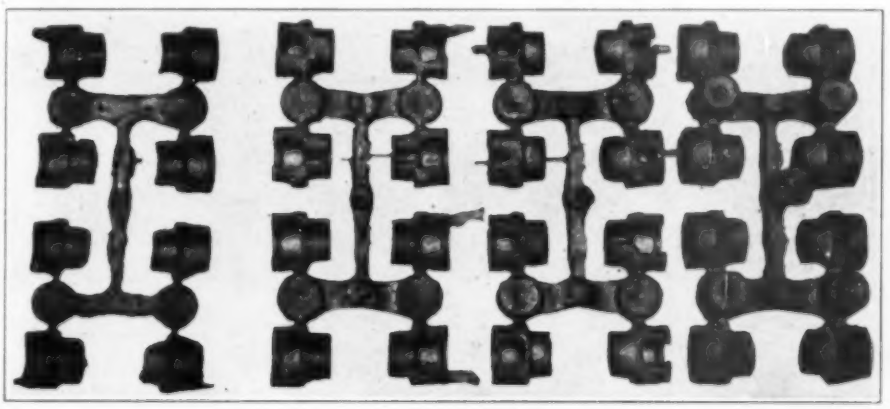


FIG. 8—LITTLE DIFFERENCE CAN BE NOTED IN THE CASTINGS ON EACH GATE

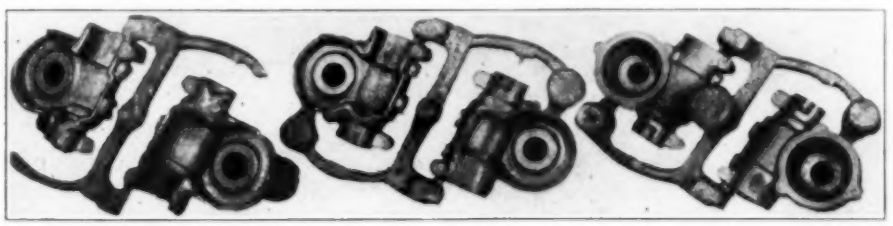


FIG. 7—THE GATES SUPPLIED METAL TO THESE CASTINGS EVENLY

ommendation to avoid using, coincidentally, the high limit for manganese with the low one for sulphur, and contrarywise. The manganese should be increased with increase in sulphur, and with the latter at 0.12 per cent it should lie between 0.34 and 0.40 per cent. However, it happens, that at this percentage of sulphur the metal has a frame-producing tendency, by which is meant that upon annealing the carbon, instead of diffusing out of the iron in a manner that will leave a decarbonized surface rim of ferrite, surrounding a core of normal structure, there will exist between the fer-

Assuming then that all hard-iron castings have a partially decarbonized surface prior to being heat treated, it is certain also that the hotter the iron as it enters the mold the more compiete and the deeper will be this decarbonized surface. If the practice is such that the molten metal is given a high degree of superheat in order that it can be distributed in large ladles, the molds first poured will have a deeper decarbonized surface than those last poured, and are liable to develop frames.

Now, while it is essential that a decarbonized surface must be in existence before a frame can be produced, it is the author's belief that it is the

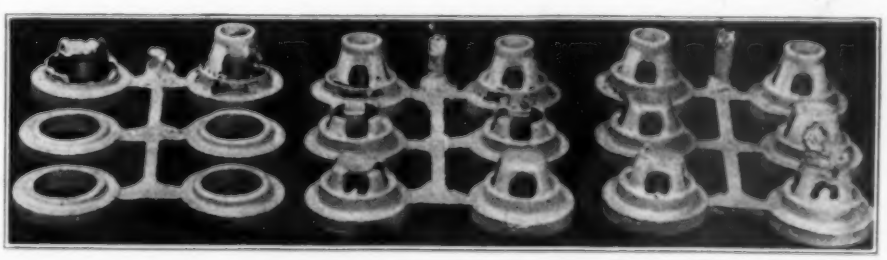


FIG. 9—CASTINGS FARTHEST FROM THE GATE DID NOT RECEIVE THE METAL AS QUICKLY AS THE OTHERS

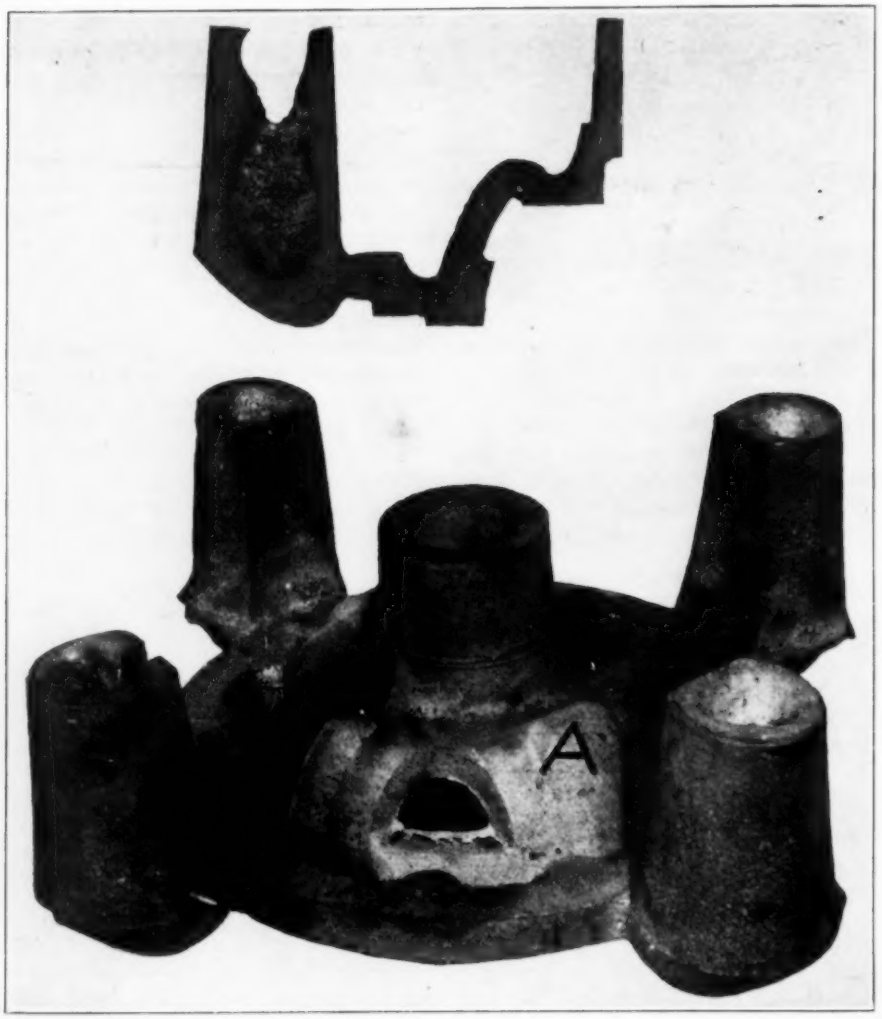


FIG. 10—NOT ONLY DOES THE RISER WEIGH MORE THAN THE CASTING BUT IN ADDITION A STRAP WAS PLACED ON THE CASTING AT *A*

rate at which the carbon in the core tends to diffuse into the decarbonized rim and the completeness with which the carbon continues to be removed from this rim that determines whether a localized carbon content will be built up and maintained in equilibrium at the junction of the two. The fact that test wedges from the same heat, but annealed in different pots have been found in which one wedge was framed and the other not, must lead to the conclusion that the rate of diffusion referred to plays an important part in this reaction.

Then again the author has proved that the depth of frame is a function of the temperature, for in the case of wedges poured from the same ladle in the same flask, and heat treated at different temperatures, the heaviest frame in every case accompanied the highest temperature. In the case of frame producing mixtures the composition must be such that the rate of diffusion favors the building up of the pearlite ring. The author is inclined to believe that this attitude towards the frame-producing mixtures is entitled to some weight in considering its causes.

Fig. 12 is a micrograph, taken at about four diameters, of a sample of steel containing 1 per cent carbon that was placed in a pot, together with the hard iron castings that were about to be heat treated,

FIG. 12—STEEL ANNEALED IN A POT WITH MALLEABLE CASTINGS—X 4 DIA. —NOTE THE PICTURE FRAME STRUCTURE

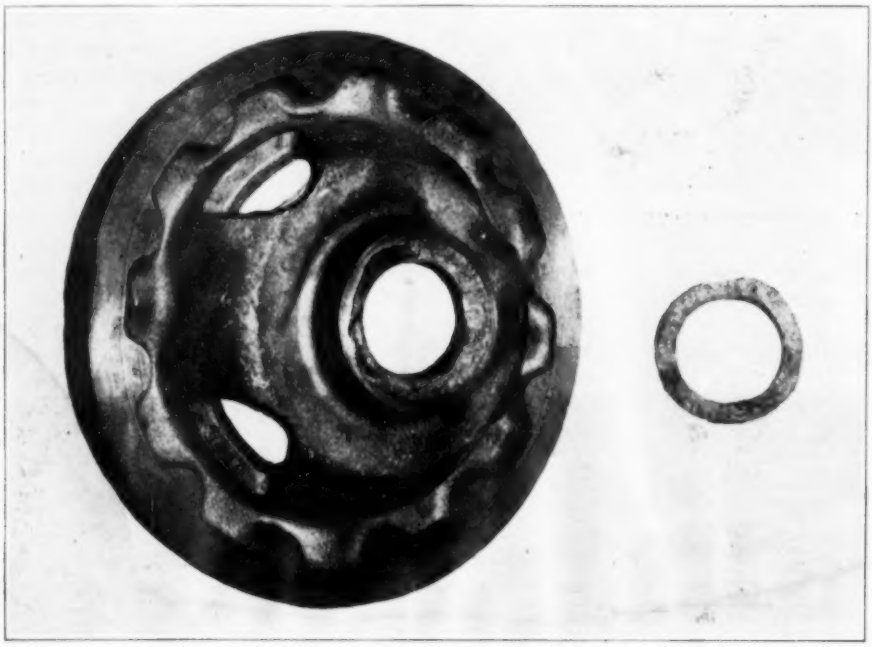


FIG. 11—SHRINK, SHOWN AT THE FILLET WHERE THE SMALLEST DIAMETER MEETS THE LARGER, IS DUE TO LACK OF RISERS

and given the same treatment as is ordinarily given malleable iron. A well defined pearlite ring located between the surface border and core, exactly as happens in the case of framed malleable cast iron. There is another kind of frame in which, instead of the pearlite being at the junction of the decarbonized area and the core it is directly at the surface. This, it is believed, results from a casing action due to the particular pot atmosphere existing at the time, and such as would favor the casing of the surface, which condition may be brought about in various ways, particularly when ashes that contain unconsumed coal are used for a packing. The latter condition is the worst form of frame.

both from the standpoint of machineability as well as untrustworthiness under shock.

It can be stated that the ease with which malleable cast iron can be machined is its most valuable asset, and any defect in the product that operates to retard the speed with which it can be machined is fatal. The two worst defects are the framed casting and the shrink. Of all of the troubles to which these castings are heir, the shrink is by far the most troublesome and the hardest to combat. While at one time the really hard casting—the one that was hard throughout due to an improper heat treatment—was a source of constant anxiety to the manufacturer, such castings are now rarely produced. However, it happens that silicon, sulphur, phosphorus, manganese, and carbon all can be present in ideal proportion in a hard iron casting, and the heat treatment conducted in an entirely efficient and normal manner, and still a casting may under certain circumstances be produced that will have a steely fracture and be hard to machine. Just what operated to bring about such a condition remained a mystery to the author for a long time, owing principally to the fact that in many instances in his experience he found that when it was claimed that all details of works practice had been correctly carried out it was discovered that unintentionally, he had been misinformed. In the particular case now referred to it was suggested by the management that if this was the author's thought he had better assume the responsibility for a trial air-furnace heat and subsequent heat treatment. This suggestion was adopted, with the result that, in spite of all precautions, no improvement was found in the fracture. While the author had been acquainted for a long time with the effects of chromium on the structure of annealed castings, he had not suspected until this occasion that chromium was the offender, owing to the supposed rarity of this element in pig iron in an amount that would be in any way harmful. As soon as it was ascertained that, notwithstanding the fact that every detail of the process had been safeguarded, the castings still were abnormal in fracture, the product was examined for this element which was found to be present.

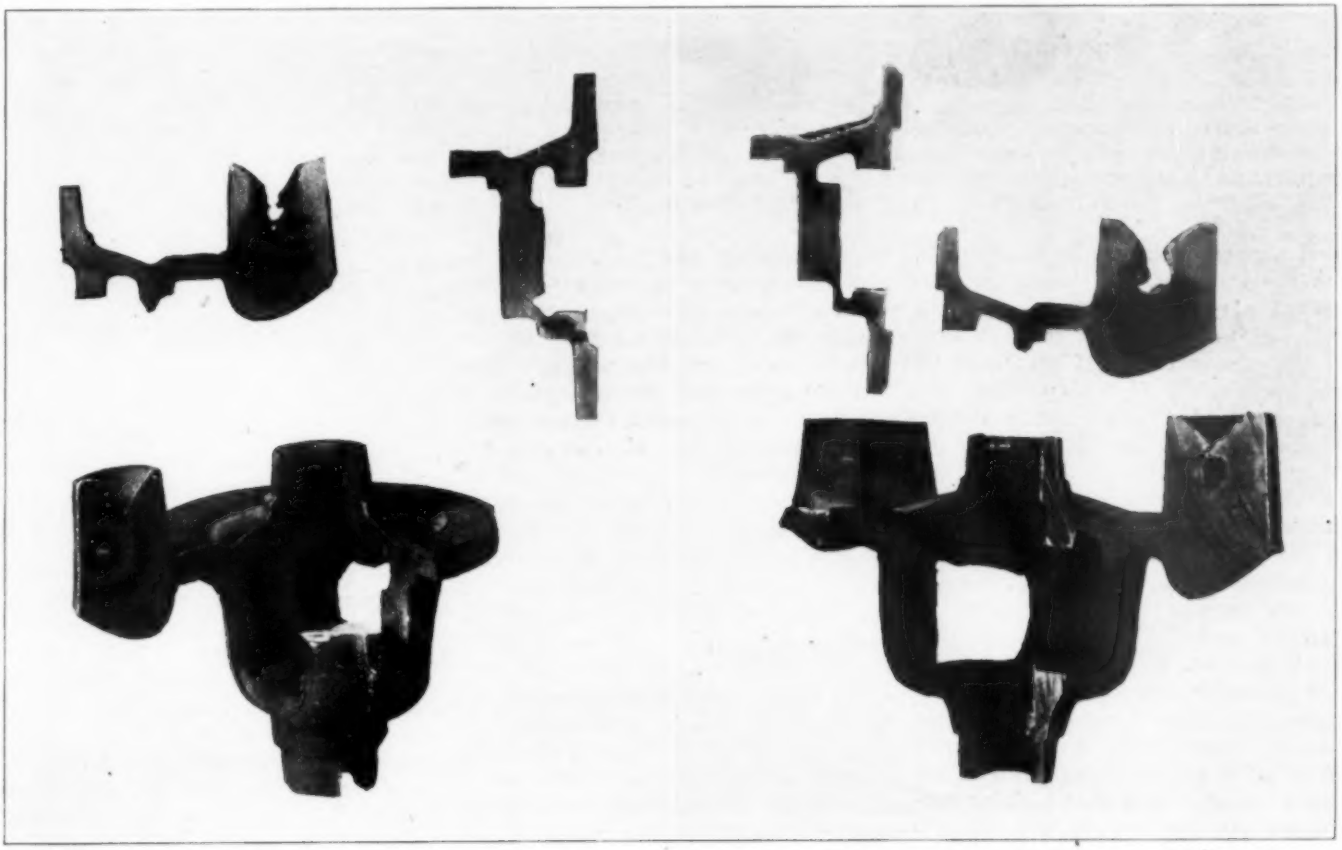


FIG. 13—OF THE TWO SECTIONS CUT FROM THE CASTING THE ONE AT THE RIGHT SHOWS A SHRINK WHILE THE ONE AT THE LEFT IS SOLID FIG. 14—A CASTING SIMILAR TO THE ONE SHOWN IN FIG. 13, BUT CUT AT A DIFFERENT PLACE

Chromium Is Deleterious

It was found that hard castings can be produced by the presence in the mixture of minute percentages of chromium, particularly if the annealing temperature is higher than normal. Not only will less than 0.1 per cent produce an abnormal fracture but this will be accompanied by a phenomenon the explanation of which proved baffling until recently. Some years ago one of the manufacturers was engaged in the production of some railway castings. One of the kilns was drawn late in the day, and as the superintendent was anxious to ascertain the quality of the product he broke the test lug on a number of the castings that were still warm, and as the fracture was normal he felt satisfied that all was well. On the following morning the railway inspectors started their examination, and not only did they find that the fracture of the test lugs was steely, but the other test lug on the castings from which the lugs were knocked off by the superintendent on the preceding day were steely. In the case of these particular castings it appeared as if one end had been properly heat treated but the other end not. The author was called to the plant, and as there happened to be available some test bars from this heat that positively could be identified, these were heated to a temperature about 300 degrees Fahr. and, when broken, showed a perfectly normal fracture, but when cooled to the atmosphere and again broken the fracture was steely. From this time on a few other cases of this

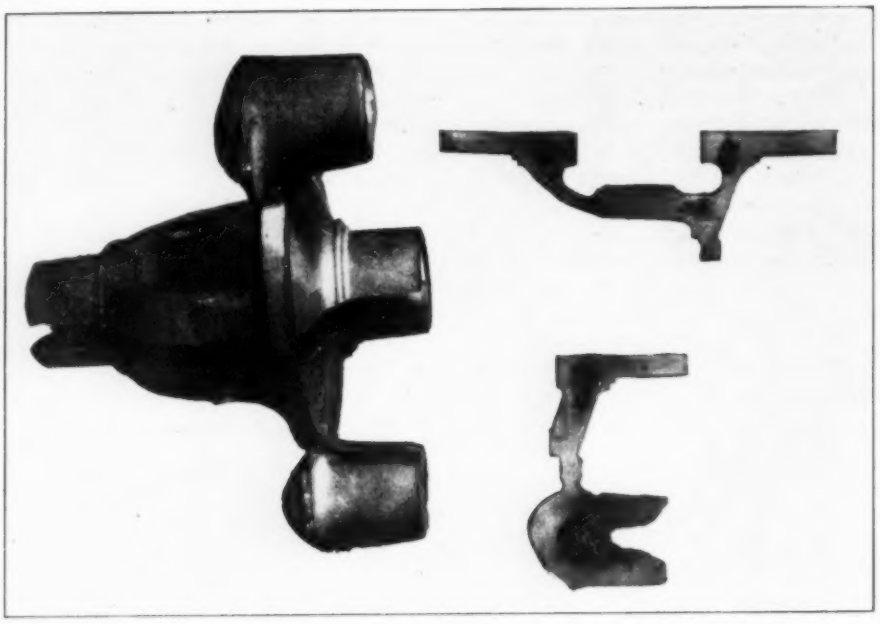


FIG. 15—EXAMPLE OF A CASTING SO DESIGNED THAT IT IS NEARLY IMPOSSIBLE TO PRODUCE IT ENTIRELY SOUND

kind came to the author's attention, but the cause of the phenomenon remained a mystery. Some time ago it occurred to the author that, in view of the curious effects of chromium on the fracture, possibly this element was the cause of this phenomenon also. Without entering into detail as to the complete investigation made, it can be stated that the author has been unable to bring about this condition in the absence of chromium, but that when exceedingly small percentages of this element are present this peculiarity exists. It also appears that the evil effects of chromium are made more manifest the higher the temperature. From the foregoing it appears that at atmospheric temperature the effect of chromium is to embrittle ferrite, while at a somewhat higher temperature—say in the vicinity of 400 degrees Fahr. the ferrite regains its ductility.

Anyone who has seen a Bullard multiautomatic machine tool at work taking cuts ⅛ inch thick at 150, and light finishing cuts at 250 feet per minute, machining a casting as fast as the operator can put one in place and remove another that is finished, will appreciate what it means if by chance one of these castings contains a shrink in the path of the tool. The tool setup on one of these machines cannot be accomplished short of some 3 or 4 hours, a loss of time that will not be tolerated.

In order that the difficulties of the situation may be appreciated, Fig. 13 is reproduced, showing a casting from which two sections have been cut. One cut is in line with the center of the head, and through a section of fairly uniform thickness. In the etched section, shown above the casting, it can be seen that there is an entire absence of shrink. About 90 degrees from this another section was machined from a part of the casting whose sections are highly disproportionate. The various shrink spots are plainly visible, and to those who have made a study of shrink the cause for their presence should be clear.

This particular casting could be gated and headed in almost any manner, with almost any amount of metal, with little hope for complete soundness in this particular section, while a slight thickening up of the narrow neck, just above the largest shrink and the removal of some metal from the very heavy section to which it is attached would enable the founder to make a solid casting, provided also some slight modification in the case of other sections was made. Fig. 14 refers to a similar casting, but cut at other sections. Fig. 15 further illuminates this matter, as well as the fact that it is up to the malleable-iron founder to protect himself and his industry by refusing to make castings that are designed in a manner such as actually inhibit soundness. In Fig. 16 is shown the etched section of half of a casting fed by two risers. In this case complete soundness is apparent. In order that the case will be fully understood it should be noted that a strap was also used in this case leading from the heads to the fillet at the neck of the casting, which facilitated and made perfect the feeding at the fillet.

In conclusion, the author would state that the future for this industry in the United States is most promising. The manufacturers are determined that they are going to get all out of the product in the way of tenacity, ductility, and shock resisting properties that investigation and improved apparatus can make possible. Any metal possessing the best machining properties of any ferrous product and having an average ultimate strength exceeding 57,000 pounds per square inch, a yield point approximating 36,000 pounds per square inch, accompanied by an elongation that easily can be made to average day in and day out, at least 20 per cent, has a future that is encouraging. Americans would all welcome the aid and co-operation of the many noted British metallurgists.

While the author has experimented with some of the ferrous additions, no results were obtained that have given promise of an improvement of product. All of the deoxidizers have been tried, and in no case has any improvement followed their use. It is the American hope that British scientists may in the near future develop some improvement in the process that will serve to make an excellent product still better.

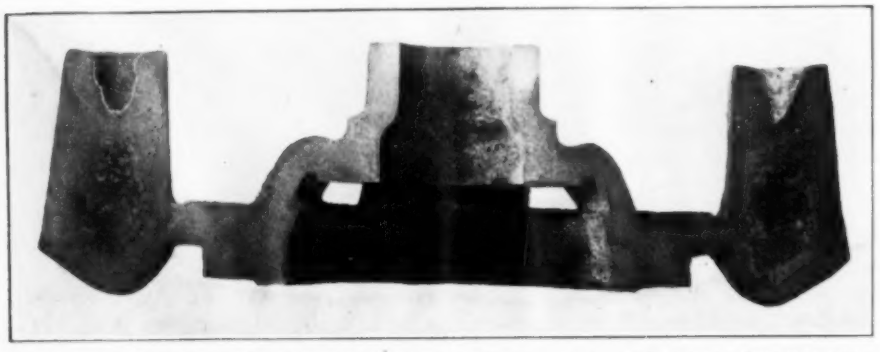


FIG. 16—ETCHED SECTION OF A CASTING FED BY TWO RISERS—NOTE THE SECTION IS ENTIRELY SOLID

Builds New Foundry

A foundry has been added to the plant of the Fitchburg Screen Plate Co., Fitchburg, Mass., and castings for paper mills will be made a specialty. The company has been a manufacturer of screen plates for paper mills. Walter S. Hall is treasurer and general manager.

Hard to Match Patterns on Single Plates

Question—We are interested in the manufacture of small brass castings and read with interest an article by Raymond H. Sullivan published in the June 15th issue of THE FOUNDRY describing the manufacture of this class of castings at the plant of the Yale & Towne Mfg. Co., Stamford, Conn. The molds we make are similar in appearance to those shown in the illustrations accompanying the article referred to, but we experience considerable difficulty in making single-side reversible plates accurately for this type of mold, viz.: a mold with a peg and a hole on each side. Could you advise us what is considered the best method for making plates for this kind of work.

Answer—These plates may be prepared in a number of ways depending on the size and shape of the patterns and flasks and to a certain extent on the manner in which the molds are to be made. Patterns and plates designed to be used on power operated machines usually are more substantially constructed than where the molds are to be rammed by hand on the bench. However, since you are interested principally in the preparation of flat one-sided plates we shall confine ourselves to that one particular method. Two perfectly flat plates, exactly the same shape and size, with the edges planed true and with the corners exactly rectangular are laid side by side on a surface table and their upper surfaces chalked. Center lines and as many guide lines as may be considered necessary are scribed longitudinally and transversely on the surface of both plates.

Two holes are drilled at suitable points through each half pattern and then the patterns are laid on the plates and located accurately by means of the center and guide lines. After they have been located the outline of each pattern is scribed on the plate and in addition a small center punch mark is placed on each pattern and similar mark placed on a corresponding point on the plate. The patterns then are all laid to one side on the bench after which they are taken in turn one at a time and clamped to the outlined position on the plate. A drill slightly smaller than the one used in forming the holes in the patterns is employed to form a continuation of the holes into the plates. After all the holes have been drilled and tapped the patterns are replaced on the plates and attached firmly by means of suitable screws provided with countersunk heads. It is unnecessary to add that the greatest care and accuracy must be observed in locating the patterns so that the two halves of the mold will coincide entirely. Another method which has been found of great assistance in securing accuracy of location consists in laying a sheet of fairly stiff paper on the first plate. The center and guide lines are laid out on the paper as in the first instance. After the patterns have been located on the paper the outlines are cut through with a sharp knife. The paper then is transferred to the second plate where it provides an accurate guide for setting the patterns on the second plate. This method is particularly advantageous where the two halves of the pattern are right and left hand. It readily is apparent that if the paper is cut on the right hand plate and then turned upside down on the left hand plate it will serve as an accurate guide in locating the patterns on the second plate.The holes are drilled and tapped in the same manner as outlined in the first instance.

Effects Business Change

R. D. MacMillen, sales manager of the Wm. H. Rankin Co., New York, has resigned effective Aug. 15. On that date he becomes associated with Albert Frank & Co., New York, where he will take charge of general and industrial advertising. Mr. MacMillen formerly was advertising manager and later sales manager of the Oxweld Acetylene Co., resigning to become secretary of the Prest-O-Lite Co. and administrative officer of other units of the Union Carbide group. Later he became vice president and general manager of Murray Howe & Co., which later was merged with the Wm. H. Rankin Co.

Studies Possibilities of Foreign Field

Henry Harnischfeger, president of the Pawling & Harnischfeger Co., Milwaukee, has just returned from a six months' tour around the world. Mr. Harnischfeger visited Japan, China, the Philippine Islands, India and several European countries. The object of the trip was the investigation of business conditions and possibilities in the Far East, particularly in Japan, China and India, where his company has a number of branches.

Mr. Harnischfeger found these countries suffering from the effects of the world-wide business depression, since a large over stock of materials of all kinds must be used before new supplies will be needed. Contrary to the general opinion there is a growing market in the Far East for labor-saving machinery of all kinds. This is due to the fact that labor conditions are slowly reaching a point where costs of construction and manufacture are not too high. Furthermore, in spite of the fact that labor is cheap it is so inefficient that the labor costs on projects cannot be figured much lower than in this country.

Considerable activity is noted in the steelmaking line and also in large civil engineering projects, such as power plants, drainage, irrigation and building construction.

The people of India are well disposed toward American-made goods. They feel the vastness of their own country and of ours brings similar problems and for this reason they believe that the machinery which Americans designed for the construction of the Erie canal, Panama canal, Mississippi flood control and other projects will meet their conditions. This experience of United States manufacturers has not been shared by European manufacturers since they never have had to contend with construction on such a large scale. The two great differences which exist between the conditions in India and United States are the class of labor and weather and climatic conditions.

Another feature which must be taken into account in the design of equipment for use in eastern countries is the fact that their bridge capacities and clearances are much less than ours and for this reason, for the present at least, mobile equipment must be built so that it may be dismantled readily.

Welding Firm Expands

Air Reduction Sales Co., 342 Madison Ave., New York, has under way a system of expansion which will add several new plants to its equipment. Sites have been purchased for an acetylene plant at Birmingham, Ala. and oxygen plant at Milwaukee, and an acetylene plant and a calorene plant at Pittsburgh, the last two augmenting the recently completed oxygen plant in the same city. Construction of the plant at Birmingham has already been started and plans are well along for the erection of the plant at Milwaukee and Pittsburgh. In addition to these new plant installations the company's facilities for producing oxygen from the air will be enlarged in Buffalo and Minneapolis. The estimated cost of the proposed extensions is over half a million dollars.

Finds Etching Reagent

A reagent consisting of an aqueous solution of ammonium persulphate has been found by the bureau of standards to reveal most of the structural features of iron and steel, which ordinarily are revealed only by deep etching. The new reagent has the advantage of not spoiling the specimen for further examination.

Gears Affect Ladle Operation

Trace Direct Relation of Different Types of Gearing To Ease in Handling and Safety—Compare Worm, Spur and Helical Worm Gears—Points on Care of Equipment Emphasized

BY A. W. GREGG

GEARED ladle design merits study and presents more engineering problems than casual and superficial attention would indicate. Foundry methods and equipment have been undergoing changes during the last 10 years, but regardless of what developments may be expected in the foundry of the future, it is reasonably safe to predict that ladles will be used to carry the molten metal from the cupola or furnace to the molds. The majority of ladles in use are geared, the exceptions being bottom-tap types for large steel castings and hand and shank ladles for small castings.

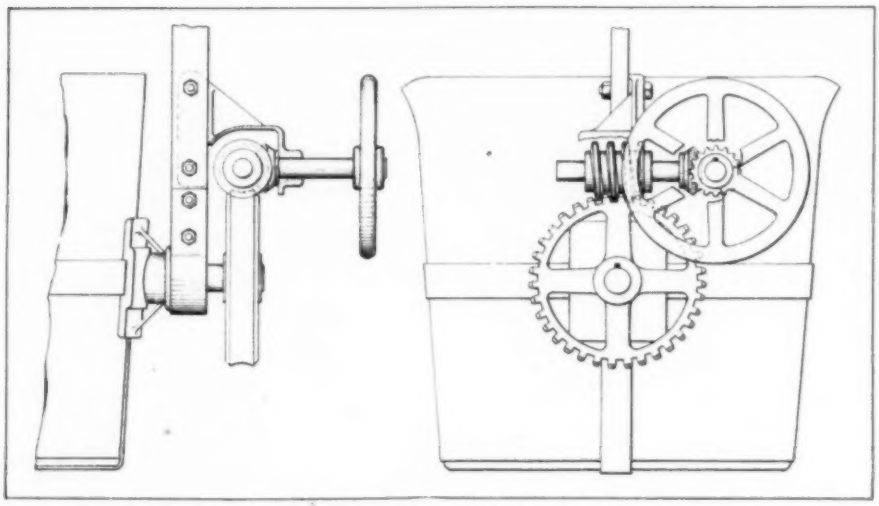


FIG. 1—SIDE AND FRONT VIEWS WHICH SHOW THE ARRANGEMENT OF WORM GEARING ON A FOUNDRY LADLE

Unless a geared ladle is designed and cared for properly, it is an endless source of trouble and danger in the foundry. In the first place it is used daily. Heat from the metal and from the ladle heater cause expansion of bail and bowl, followed by contraction on cooling. With most styles of geared ladles the expansion and contraction affect the alignment of the gearing. In many foundries the lubrication of ladle gears and trunnions receives little attention, and this neglect results in excessive wear. For a time this causes hard turning and later too much play in the gearing. Unless grease cups and oil holes are located so that the lubricant gets to the bearings and gears properly and in sufficient quantity, the ladle gearing will suffer, no matter how much care is exercised.

When lost motion is present in the gearing a dangerous drop of the ladle occurs during pouring, caused by the flow of the metal. This usually results in a splash of molten metal which may cause serious injury to several men. On the other hand, if the gears are too tight and bind, pouring is an arduous task which cannot be performed properly, and cold-shut or misrun castings result.

The important features of geared ladle design fall under the following classifications:

1. Type of gearing
2. Gear ratio.
3. Design of housing
4. Location and type of trunnion.

Geared ladles usually are classified according to their type of gearing. This and the gear housing are the features of greatest interest and importance. There are three types to be considered, namely, worm, spur and helical-worm.

The first type of gearing to be applied to a ladle was the worm, which is illustrated in Fig. 1. Worm gearing has been used on ladles in this country for from 70 to 80 years. The principal improvement which has been made in this time has been the substitution of cut tooth gears and cut worms for cast. The gearing is compact in design and is fitted with bevel pinions which allow the extension of the handwheel shaft at right angles. When the gearing is in good condition and perfect alignment it permits a smooth and easy turning action which affords good control of the stream of metal flowing from the ladle to the mold. One of the greatest advantages of worm gearing lies in the fact it is self-locking The disadvantages are its tendency to bind unless in perfect condition; the fact that it is relatively slow; and the low efficiency of the gear train which makes it harder to turn than the other types. Most ladles in use at present in this country have worm gearing. The spur-geared type illustrated in Fig. 4 was introduced into this country about 30 years ago in some of the pipe foundries, where a ladle operating faster than worm gearing permitted was desired. Where fast pouring is required this gearing still is used largely. High gear efficiency and less tendency to bind than worm gearing are among its advantages. One of its disadvantages is that it tips the ladle in a slightly jerky manner due to the finger pinion which is necessary to get gear reduction with compact design. This jerky action causes uneven pouring and a tendency to form a skull on the sides of the pouring lip as the metal washes up and down. However, the most serious trouble with the spur gearing lies in the fact that it is not self-locking.

The third type of gearing, known as the helical-worm is a recent development and eliminates many of the troubles found in the two older types. The most important feature of this gear mechanism lies in the fact that, unlike the first two types described, the housing is mounted on the trunnion and has no attachment to the bail except through a sliding support. This results in making the tilting mechanism an independent unit, and the alignment of the gears is not affected by distortion of bail or bowl or by wear on the trunnion journals.

The gear combination has an efficiency about 33 per cent higher than

From a paper presented at the Rochester, N. Y., meeting of the American Foundrymen's association held June 5-9, 1922. The author is with the Whiting Corp., Harvey, Ill.

that of the worm and is self-locking. Because of the balanced thrust obtained through the helical gears the turning action is smooth and requires little power. The helical gearing permits a wide range of tipping speeds to be obtained, by interchanging the helical gearing with another set of different helix angles.

Fig. 2 shows the gear ratios ordinarily used for ladles of from 1500 to 40,000 pounds capacity for worm and helical worm types. The ratio is determined primarily by the size of the ladle and the desired speed of pouring. The gearing ratio as used in Fig. 2 is the number of revolutions of the handwheel for one complete revolution of the ladle. Four different ratios are shown for each size of

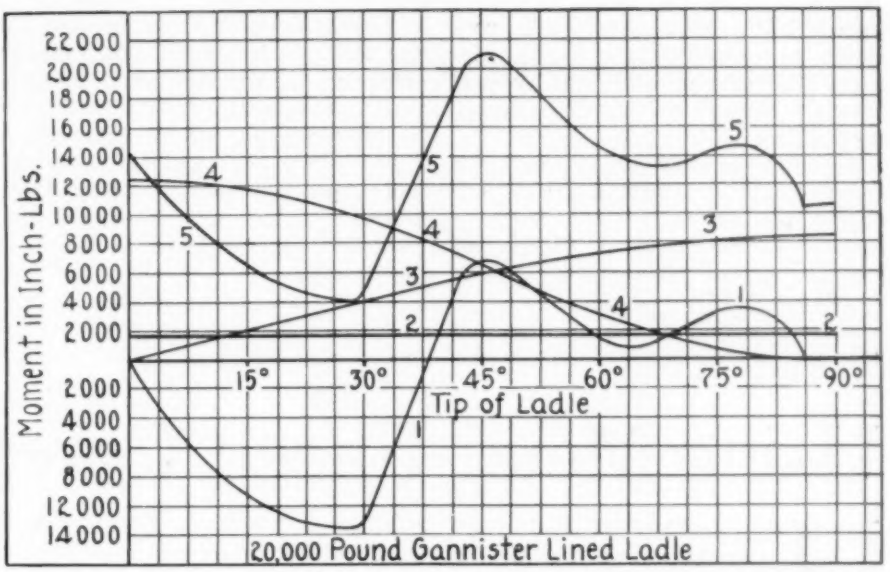


FIG. 3—THE CURVES SHOW THE TURNING MOMENTS OF A 10-TON LADLE

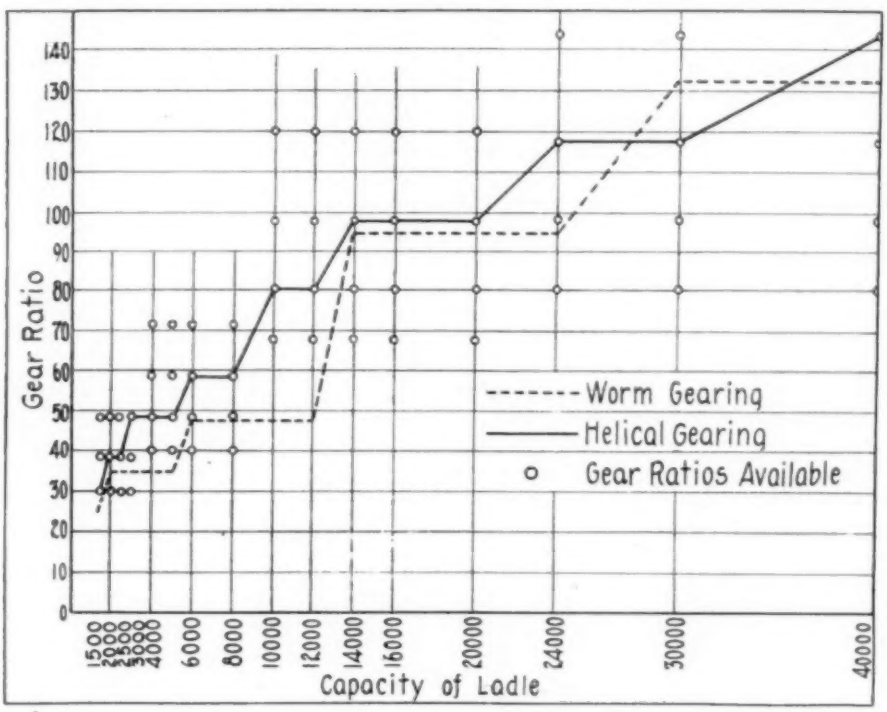


FIG. 2—RATIOS FOR GEARS ON LADLES WHICH HAVE FROM 1500 TO 40,000 POUNDS CAPACITY

ladle with the helical gearing and one ratio for each size with worm.

The location of the trunnion is a matter of importance in the design of any ladle. The customary practice is to place the trunnion at practically the center of gravity of metal and ladle in an upright position. Fig. 3 shows the turning moments of a 10-ton ladle at various angles. The curves show the moments due to friction, eccentricity of ladle and metal and also the total moment. These curves are based on the results obtained in a series of tests conducted to determine trunnion location for which two factors must be taken into account. The effort required to tip the ladle in pouring direction and the effort required to right the ladle from any position must be considered. In curve No. 1, Fig. 3, the moment is due to eccentricity of metal; No. 2 due to trunnion friction, weight of ladle only; No. 3, due to eccentricity of ladle; No. 4 due to trunnion friction, weight of ladle only; No. 5, total of these moments.

By moving the trunnion one inch upward, the moment required to right the ladle is decreased about 8000 inch-pounds with the ladle at 30 degrees, while the effort required to tip the ladle in the pouring direction is increased about 8000 inch-pounds at 45 degrees. Lowering the trunnion 1 inch, reverses the conditions; that is, the moment required to right the ladle at 30 degrees is increased 8000 inch-pounds and the moment to tip the ladle in pouring direction is decreased about 8000 inch-pounds at 45 degrees. Thirty degrees is the angle

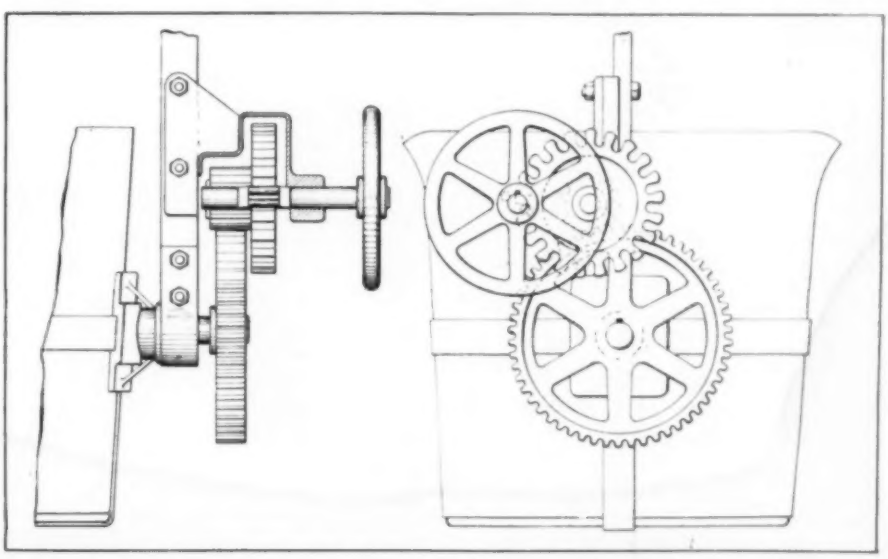


FIG. 4—TYPICAL SPUR GEAR EQUIPMENT WHICH TIPS THE LADLE

at which the greatest effort is necessary to right the ladle and 45 degrees the angle at which the greatest effort is required to tilt it in pouring direction.

The force required on the handwheel for the ladle as described may be calculated for any angle by dividing the moment at that angle by the gearing constant shown. This constant, which is known as the moment ratio, is 530 for helical and spur gearing, and 400 for worm gearing. The result is derived by taking into account the size of the handwheel, the gearing efficiency and the gear ratio. For example; at 45 degrees for a 10-ton helical geared ladle, the total moment is 21,000 inch-pounds and the force required on the hand wheel is 21,000 divided by 530 or approximately 40 pounds. This calculation is based on dry bearings.

Other points of importance in ladle design are the types of trunnion and bail. Both should be of rolled mild steel and in calculating the size a factor of safety of about 10 should be used.

Foundrymen have been prone to consider ladle trouble a necessary evil of the foundry business and something to be endured. This is not true. Proper care and proper design will do away with most of the troubles encountered with geared ladles. Safety should be placed above all other considerations in the design and use of ladles.

Using Metal Faced Cores in Cylinders

APPLICATION of metal faced cores practiced by T. P. Greenhow at the plant of the United States Cast Iron Pipe Co., Cincinnati in 1910 and 1911 suggested the practicability of the same idea in the production of automobile cylinders. The method on which he has based a claim for a patent has been applied at the plant of the Buick Motor Co., Flint, Mich., where he has been general foundry superintendent for the past five years. The claim is not advanced that the principle of employing iron inserts either in the mold or the core to cause iron in the casting to set rapidly and thus close the grain, is original. The patent claim is based on the method of application and also on the preparation employed to cover the metal face of the core to prevent the metal from chilling.

About two years ago Mr. Greenhow started a series of tests with a view of determining whether or not it was possible to regulate his gray iron mixture to give a uniform hardness in the metal forming automobile cylinder barrels. These mixtures varied over a wide range, but the results were unsatisfactory. Test block samples although poured from the same ladle as the cylinder block and cooled under identical conditions, did not reveal the true physical condition of the barrel wall. Frequently when the brinell number on a test block was 235, or over, a section cut from that part of the barrel covered by the water jacket tested as low as 146. Where the test blocks did not show a high number, usually the barrel tests approached nearly to the specification limits. Brinell tests taken on opposite sides of a wall section cut from between two barrels disclosed the fact that while one cylinder apparently was satisfactory from a hardness viewpoint the other was below the specification limit.

The experiments seem to indicate that even in cases where the iron mixture is quite hard the barrels will be from 5 to 30 per cent softer in the section under the water jacket than in the part which is exposed. This condition has been found in cases where the flanges, bosses and other exterior parts were so hard that they had to be machined at reduced speed and in extreme instances where the castings had to be rejected because they could not be machined even at reduced speed. This is accounted for by the annealing effect of the hot air circulating through the water jacket around the barrels during the process of cooling and unfortunately it occurs at a point traversed

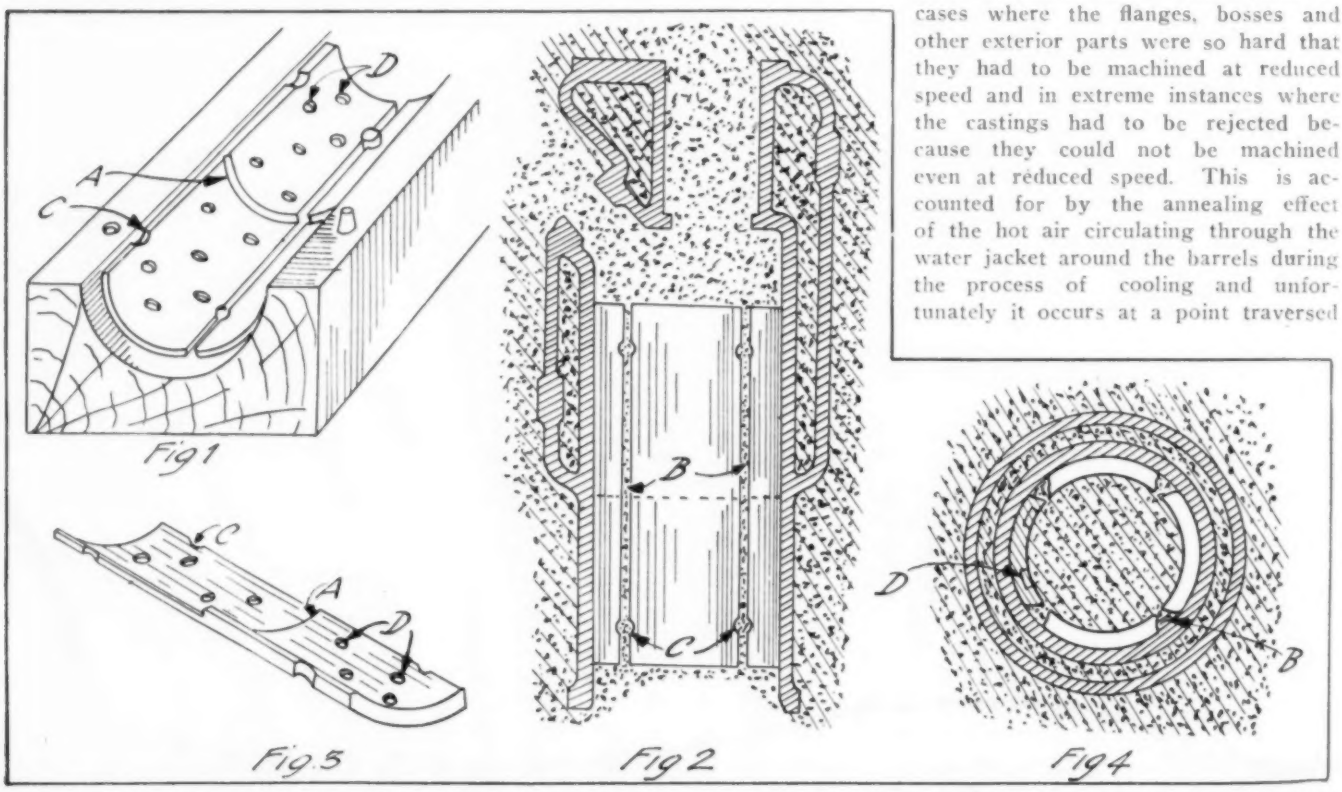


FIG 1—HALF COREBOX WITH METAL COREPLATES IN PLACE FIG. 2—LONGITUDINAL SECTION OF CYLINDER CASTING IN THE MOLD FIG. 3—ONE OF THE METAL PLATES FIG. 4—CROSS SECTION OF CASTING AND MOLD THROUGH WATER JACKET

by the piston where the wear resisting quality should be most pronounced.

Barrels cast on metal faced cores, when finished, present a dense, smooth surface, indicating, it is claimed, a uniform crystallization brought about by a thorough breaking up and even distribution of the graphitic carbon. A surface of this character is ideal for lubrication. In the past two months 20,000 cylinder blocks have been cast in conformity with this method and samples cut from 200 of these blocks showed an average brinell test from the top to the bottom of the barrel of 200. The average brinell under varying conditions according to Mr. Greenhow, is shown in tabulated form in the accompanying table. The patentee states that this hardness is not obtained by giving even the surface wall of the barrel a distinctive chill, but is due to increased density extending through the entire thickness of the barrel wall. Samples cut from these barrels and machined down to half their thickness, showed a brinell hardness equal to that indicated on the surface. The accompanying illustration will serve to explain more fully the core making details. One of the cylinders is shown in Fig. 2. From the irregular shape and the distribution of the various cores it is apparent that the casting will not cool uniformly.

Face Plates Vary

To compensate for variation in the mass of metal forming the casting and also for the annealing effect due to the presence of the water jacket core, the segmental face plates are made with an offset or shoulder indicated at *A*, Figs. 1 and 3. The four plates forming the circle on the face of the barrel core are spaced about 3/16-inch apart as indicated at *B*, Figs. 2 and 4 to allow the casting to contract and also to permit the easy removal of the plates from the casting in the cleaning room. The plates are provided with marginal notches *C*, which engage locating pins in the bottom of the corebox. A number of depressions *D* are provided on the concave face of the plates to anchor them to the sand body of the core. In addition a draft, or taper on the sides, *A*, assists in holding the plates in place during the various processes the cores pass through from the time they leave the corebox until they are knocked out of the finished casting. After the cores are dried and before they are placed in the mold they are coated with a special preparation to cause them to leave the barrels easily and to impart a smooth surface.

Comparative Brinell Hardness of Cylinders

SAND CORES		METAL FACED CORES	
Top	Bottom	Top	Bottom
170	187	196	196
166	187	196	196
156	174	202	196
163	179	202	196
143	179	196	196
143	187	196	228
144	183	196	228
146	187	202	212
163	183	207	212
183	196	207	217
159	192	212	212
163	196	207	217
166	196	217	212
179	207	207	207
170	192	207	207
166	179	207	192
166	202	207	207
159	192	207	202
153	192	202	202
163	187	202	196
159	183	207	196
Average—		Average—	
Top—164	Bottom—189	Top—203	Bottom—206

In each of the above cases the metal cast against sand cores was barely machinable, while the metal cast against metal faced cores was machined at productive speed.

Analyses of Samples from Specimens Tested

	SAND CORES			METAL-FACED CORES		
Silicon	1.90	2.39	2.16	2.97	2.99	3.30
Sulphur	.123	.138	.125	.121	.099	.107
Phosphorus	.13	.13	.12	.13	.21	.14
Manganese	.70	.69	.82	.52	.66	.67
Combined carbon	.46	.37	.39	.10	.16	.07
Total carbon	2.97	3.17	3.10	3.02	3.27	3.17

Pattern Numbers Defeat Their Object

By M. E. Duggan

Recently I saw an item in one of the technical papers to the effect that machinery manufacturers were considering the advisability of adopting a standard method of marketing their product. This is a measure which should appeal to users of machinery in a general way. Looking up the number or name on an old casting is a job I dislike because in a great many instances the figures or letters are located on a part of the casting where it is impossible to find them.

The complaint frequently is made by a manufacturer or his agent that he is unable to furnish a certain repair part because the customer has failed to supply the serial number of the machine or the pattern number of the individual part wanted. He does not take into consideration the fact that this number is hidden away on some part of the assembled machine where it is a physical impossibility for any person to see it.

It was necessary on a certain occasion to replace the broken door on a furnace. The name of the furnace, which really meant nothing, was cast in large letters on the front of the door, but the identification letters and figures were cast on the inside and in this instance were covered with a firebrick lining. To secure the information it was necessary to shut down the furnace and remove the lining from the door.

If there are any choice spots on the pattern that—when the machine is assembled—are exposed to view, quickly found and easily read, those are the places to put information for the ultimate user. The patternmaker usually is not in a position to decide just where these favorable positions are located and therefore some person in authority who does know should see that this information is set down on the drawing from which the patternmaker works.

The patternmaker unless instructed otherwise will fasten the pattern letters and figures on some point on the pattern most convenient for himself and the molder. Again, many patternmakers, especially advanced apprentices and young journeymen, object to placing a lot of ugly pattern letters and figures in a prominent place on a pattern to which they have just given a piano finish.

Occasionally it is found that the letters or figures have been placed on the pattern, but their reproduction on the casting is blurred and indistinct. Sometimes this is the molder's fault and at other times it is caused by using a style of type unsuitable for the purpose. Unless definitely instructed to the contrary I always employ hair-line figures and letters on my patterns.

Charles A. Reagan, formerly connected with Briggs & Turivas, Chicago, has been placed in charge of the new scrap iron and steel department of David Evans & Co., 3720 South Kedzie avenue, Chicago.

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Foundry Presents Opportunities

IN THESE modern days when many a young man's ambition is to lead a care-free, joy-riding life, without the necessity of working, it requires real courage on a boy's part deliberately to enter a foundry with the intention of learning the molder's trade. Usually his father is opposed to the idea and almost invariably his mother bewails the fact that all the years of her training and cleaning have been thrown away. She cannot see why he should prefer old clothes and the dirt and grime of the foundry, to a nice genteel position, for example, in a bank or behind a counter, and as a final argument she implores him to consider what the neighbors will think and say when they learn he is engaged in such menial work.

Opinions may differ on the many causes responsible for the dearth of apprentices in the foundry trade, but whatever the causes may be, the fact is becoming more notorious every day and is adding another straw to the heavy load already carried by the thoughtful foundry manager. Economic conditions always are in the scales of a balance. When the beam is up at one end it is down at the other and the foundry industry rapidly is approaching a period where a scarcity of skilled men, automatically and according to the inexorable law of supply and demand will place a premium on their services. Eventually, it is probable that conditions will adjust themselves and men and methods will be equal to all demands made upon them, but all processes of evolution are slow and in the natural order of events the foundry will present a remunerative field to competent men for many years to come. The foundry business is not a bed of roses, but that fact will not interfere with the young man who has ambition and vision enough to realize that the future holds an appreciable reward. His bones and muscles may ache for some time, but soon he will arrive at a stage where the days work simply serves as a medium to keep him in good physical trim. Unfortunately there is no royal road to learning and the young foundryman has several years of hard, dirty work ahead of him before he has mastered the rudiments of the trade and can qualify as a director of others. A knowledge of the theories on which foundry practice is based is necessary to enable a man to reason from cause to effect, or, what is just as frequent in the foundry, from effect back to cause. Conversely, an actual knowledge, gained through personal experience with mechanical and manual processes also is required.

The great majority of foundrymen do not pretend to teach a boy the business, but let him grope along by himself. Even under such conditions a determined boy can learn a great deal if he applies himself diligently and supplements his shop practice by home study of technical literature, or, of a correspondence course devoted to foundry subjects. Several of the large establishments maintain a regular training course for their apprentices in which the instruction is so thorough that many of the boys are fit for, and obtain, executive positions immediately after they have finished serving their apprenticeship. A candidate for a responsible position in a foundry must have other attributes in addition to mechanical ability and a knowledge of the fundamentals involved in foundry practice; but usually when a boy deliberately chooses a trade and exhibits the necessary stamina and ambition to carry him through, it safely may be assumed that he is competent to carry through to a successful conclusion any problem he encounters afterward.

Trade Outlook in the Foundry Industry

WITHOUT the overshadowing effects of the mine and railway strikes, the foundry industry would be well established in a prosperous period. Only a few sections have been directly affected by the shortages in fuel and other materials incident to the labor difficulties; but the influence upon castings demand and upon the future purchase of foundry products for manufacturing purposes is marked. The situation might better be termed unsettled than unfavorable, except in the case of a few foundry centers where supplies are curtailed. The full force of the coal priority order of the interstate commerce commission has not been felt, though the preferential movement of fuel has started.

Foundries Forgotten

Apparently no notice is taken of the metallurgical industries in providing for the distribution of coal. As has been noted previously, foundries will be among *others* not classified, at the bottom of the list. However, with the state of coke stocks in many sections and the possibility of an early settlement of the strikes, the pinch may not be felt. The slackening in demand for castings cannot but parallel closely the dwindling stocks of fuel and iron. Therefore, the main difficulty will arise with the start of operations, when the backed-up demand will be followed by a steady pressure to increase production, and doubtless transportation troubles will follow. A severe tax upon the railway facilities undoubtedly will arise when coal movements and fall crop marketing bring heavy car requirements to bear. Some effort is being made to keep up car construction, although a lull is apparent in the western requirements for both locomotives and rolling stock. Approximately 14,000 freight car orders were placed in July, showing an increase of about 1000 over June. Buying has been lighter in August.

Prices of Raw Material for Foundry Use

CORRECTED TO AUG. 10

Iron		Scrap	
No. 2 Foundry, Valley	$29.00 to 30.00	Heavy melting steel, Valley	$16.75 to 17.00
No. 2 Southern, Birmingham	20.00 to 21.00	Heavy melting steel, Pitts.	17.00 to 17.50
No. 2 Foundry, Chicago	27.00 to 28.00	Heavy melting steel, Chicago	15.75 to 16.25
No. 2 Foundry, Philadelphia	30.36 to 34.02	Stove plate, Chicago	16.75 to 17.25
No. 2 Foundry, Buffalo	30.00	No. 1 cast, Chicago	18.50 to 19.00
Basic, Valley	25.00 to 27.00	No. 1 cast, Philadelphia	18.00 to 20.00
Basic, Buffalo	30.00	No. 1 cast, Birmingham	15.00 to 15.50
Malleable, Chicago	27.00 to 28.00	No. 1 cast, Buffalo	18.50 to 19.50
Malleable, Buffalo	30.00	Car wheels, iron, Pittsburgh	18.50 to 19.00
		Car wheels, iron, Chicago	20.50 to 21.00
		Railroad malleable, Chicago	19.00 to 19.50
		Agricultural mal., Chicago	18.75 to 19.25
		Railroad malleable, Buffalo	17.00 to 17.50
Coke			
Connellsville foundry, coke	$15.00 to 17.00		
Wise county foundry, coke	13.50 to 14.00		

Auto Needs Lighter

No one would venture to predict the future trend in automobile production, as the industry has gone contrary to all rules of probability on other occasions during its eventful career. However, the expected period of seasonal dullness is at hand. This lull has found both manufacturers and parts producers in better condition and with lower inventories than during the past. Castings have not been ordered in such vast quantities during the spring and summer, nor have they been produced in anticipation of a heavy fall demand. Further, foundries making automotive castings have not contracted so far ahead on materials, and consequently can absorb the shock of decreased demand much better than they could at the start of the 1920-1921 depression. A slight decline in building construction is noted, but the demand for building hardware, sanitary ware and plumbing sundries still is active. According to the department of commerce, a slight decrease in orders for bath tubs, sinks, lavatories, etc., was noted in June. The total orders for baths were 128,876 as compared with 150,475 in May, although in June, 1921 only 43,973 orders were received. Farm implement lines are more active, and the outlook for fall sales is better. Dealers stocks are low and in consequence an average demand will mean increased business both for the manufacturer and contributing foundries. Tractor sales in the rural districts are maintaining the volume of the spring months and a demand for tractors for fall plowing in anticipated. Despite the loss of the production of about 26 blast furnaces during July, the month's total was 2,400,465 tons of pig iron compared with 1,362,455 tons for June. This gave an actual increase of 38,010 tons. Merchant iron was responsible for the greater part of this gain, as the July total was 454,430 tons giving a gain of 30,758 over the previous month's total of 423,672 tons. On a daily production basis this represented 14,659 tons per day or a gain of 537 tons per day over the June average of 14,122 tons. Furnaces active on the last day of July totaled 170, compared with 191 on June 30. This is the first time in 16 months that a decrease has been noted in the number of active stacks. Apprehension over the effects of the strikes have resulted in advanced prices on pig iron.

Brass Shops Busy

Foundries have been melting much scrap and ingot copper and brass during the late summer. The activity is greater in the states adjacent to the automobile manufacturing centers. Some jobbing foundries which originally specialized in railway brass have made more castings than ever before in their history, but they have been made for the automotive trade. Plumbing goods are in demand and marine, hardware and manufacturing lines are active. New York prices on nonferrous metals for August 10, according to *The Daily Metal Trade* follow: Casting copper, 13.45c to 13.50c; electrolytic copper, 14.00c; Straits tin, 32.25c; antimony, 5.25c; lead, 5.80c to 5.85c; aluminum, No. 12 alloy, producers' price, 19.00c to 19.20c and open market, 16.00c to 16.50c. Zinc is 6.25c E. St. Louis. The July average prices for nonferrous metals follow:

(New York Quotations)

Casting Copper	Electro. Copper	Lead	Tin Straits	Antimony	Aluminum 98-99	Zinc St. Louis
13.348	13.973	5.727	31.792	5.052	18.00	5.777

Personal

Raymond D. Emery has resigned as general manager of B. D. Whitney & Son, Inc., Winchendon, Mass. builder of machinery, to accept a similar position in Detroit.

Samuel Hench has been made superintendent for the Sterling Steel Foundry Co., Braddock, Pa. Mr. Hench for the past five years has been foreman for the same company.

G. A. Woodman has been appointed sales manager of the Northwestern Malleable Iron Co., Milwaukee, Wis., with offices at 237 Railway Exchange building, Chicago.

Arthur Whitcraft, manager manganese steel sales, Hadfield-Penfield Steel Co., Bucyrus, O., in addition to his previous duties has also been placed in charge of all foundry operations at the south works at Bucyrus, O., where demand for manganese steel and special heat treated steel has made it necessary to increase production.

Wm. C. Lilly, superintendent for the past three years of the F. H. Linthicum Bronze Foundry, Baltimore, and prior to that time superintendent of the American Manganese Bronze Co. Holmesburg Junction, Philadelphia, now is superintendent of the large jobbing brass foundry of the Standard Brass Casting Co., Third and Jefferson streets Oakland, Cal.

C. N. Phillips, for the past five years superintendent of the Reading Steel Casting Co., Reading, Pa., has taken charge of the steel foundry department of the Chapman Valve Mfg. Co., Indian Orchard, Mass. Mr. Phillips was connected with the Reading Steel Casting Co. for a period of 22 years, starting as a workman and advancing by stages to the position of superintendent. He also was identified with a valve manufacturing firm in Reading.

Book Review

Galvanizing and Tinning, by W. T. Flanders; 328 pages, 6 x 9 inches; cloth; published by the U. P. C. Book Co., Inc., and for sale by THE FOUNDRY, Cleveland; price $4 net.

There are several sections that should be of special interest to foundrymen. The chapter on water rolling, tumbling, and sand blasting contains detailed descriptions of the preparation of castings for tumbling, mixtures for cleaning castings, handling delicate castings in tumbling barrels, sand blast, etc. In the chapter on coating gray iron castings with tin, the work deals with dipping the castings, proper heat for tinning, tinning with three kettles of tin. The chapter headed, "Tinning Malleable Iron Castings, Wrought Iron and Steel" takes up plant and equipment, plan of a tinning plant, tools and kettles. The section on preparing gray iron castings for tinning contains a close description of the various methods used for removing sand from castings. "Galvanizing Specifications and Tests" is a chapter of 25 pages explaining the requirements and the numerous tests. The remaining 27 chapters thoroughly cover the remaining points in the process of galvanizing and tinning. Practically every phase of the subject is completely explained and diagrammed. Over a hundred photographs and drawings help to explain the test and add to the interest of the book.

New England Founders Enjoy Clam Bake

On Wednesday, Aug. 9, the New England Foundrymen's association held their August outing at The Hummocks, Hamilton, R. I. The general arrangements for the outing were in the hands of the Providence members of the association. Edward F. Parks, Universal Winding Co., was chairman of the committee of arrangements. Sports were in charge of A. J. Miller, Whitehead Brothers Co., and C. H. Colvin, Colvin Foundry Co. Entertainment was in charge of Charles F. Colvin, Colvin Foundry Co. Transportation was provided by W. Scott Thomas, J. W. Paxson Co. After luncheon sports of every description including swimming and baseball were offered. In the middle of the afternoon the big event took place in the form of a famous Rhode Island clam bake.

To Represent New Firm

J. P. Armel, who has been affiliated with the Pittsburgh Crane & Equipment Co. for the past two and a half years selling cranes and foundry equipment, now is identified with the Kirk Supply Co., Farmers Bank building, Pittsburgh, representing several foundry equipment manufacturers, including the Sterling Wheelbarrow Co., Milwaukee, wheelbarrows, flasks, etc., and the Chesapeake Iron Works, Baltimore, cranes.

Obituary

Charles G. Cooper, founder of the C. & G. Cooper Co., Mt. Vernon, O., died at his home Aug. 3, at the age of 75. Mr. Cooper had been identified with the manufacture of engines for many years, having established the business on the site of a foundry erected by Charles and Elias Cooper at Mt. Vernon in 1833. Under the guidance of Charles G. Cooper, the business expanded, locomotives and special machinery being added to the list of products. Some time ago Mr. Cooper relinquished active participation in the direction of the business.

Charles S. Rea, aged 63 years, vice president of the Ralston Steel Car Co., Columbus, O., and a lifelong resident of Pittsburgh, died in the Allegheny General hospital, that city, Aug. 1. Death is understood to have resulted from an apoplectic stroke. Mr. Rea was striken in his downtown office in the Oliver building and was removed to the hospital immediately, where he died without regaining consciousness. Mr. Rea was connected with the Columbus company for a period of 15 years, maintaining the office of vice president at Pittsburgh and acting as a representative in the Pittsburgh territory. He was active in the civic affairs of Pittsburgh.

Chilled Roll Mixtures

By H. E. Diller

Question—I want to cast a 24-inch diameter roll with a 16-inch diameter core and a 60-inch face, having a chill ⅛ to ¼ inch deep. Should the chiller be in one or two sections and what should its thickness be? Also, what is a good mixture for this work?

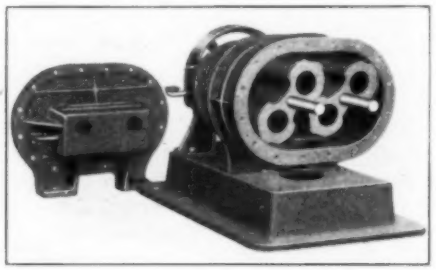
Answer—For a roll of the dimensions given you should use a chill 2½ to 3 inches thick. This should be made in two sections, divided horizontally, with machined faces. A mixture consisting of 40 per cent pig iron, 50 per cent scrap rolls or sprue and risers from the mixture, and 10 per cent steel scrap would be satisfactory. The percentage of scrap and pig iron can be varied somewhat without detriment to the metal.. The iron as it comes from the cupola should have less than 0.1 per cent sulphur; between 0.2 and 0.4 per cent phosphorus, and approximately 0.6 per cent mangnese. It is difficult to say exactly how much silicon you should use to get a chill ⅜ to ¼ inch deep, as the temperature at which you pour the metal and the amount of sulphur and manganese in the iron have a decided influence on the depth of chill. You could determine the depth of chill from a test piece cast against a chill. If you put in a charge which will come out about 0.7 per cent silicon and make a test piece against a chill, the depth of the chill on the test piece will show you whether your chill is too deep. In case the chill is too deep, about 2 to 4 pounds of pea-sized 8-per cent ferro managnese added to the ladle will lessen the chill.

Small Positive Pressure Blowers

A new positive pressure blower of relatively small capacity has been constructed by the Connersville Blower Co., Connersville, Ind., for furnishing air for oil and gas furnaces and appliances, blacksmith forges, pneumatic conveying, producing a vacuum for vacuum cleaning, etc. The accompanying illustration shows the internal construction.

The air is drawn through one opening and forced out of the other by the two impellers rotating on parallel shafts within the cylinder. These parts are made of heavily ribbed cast iron. Wide faced gears accurately cut from semisteel blanks move the impellers and at the same time maintain them in correct relation to each other. These gears are outside the cylinder in an oil-tight housing.

For protecting the blowers against higher pressures than they are designed for, all machines are equipped with the non-vibrating relief valve. With a fan the discharge may be

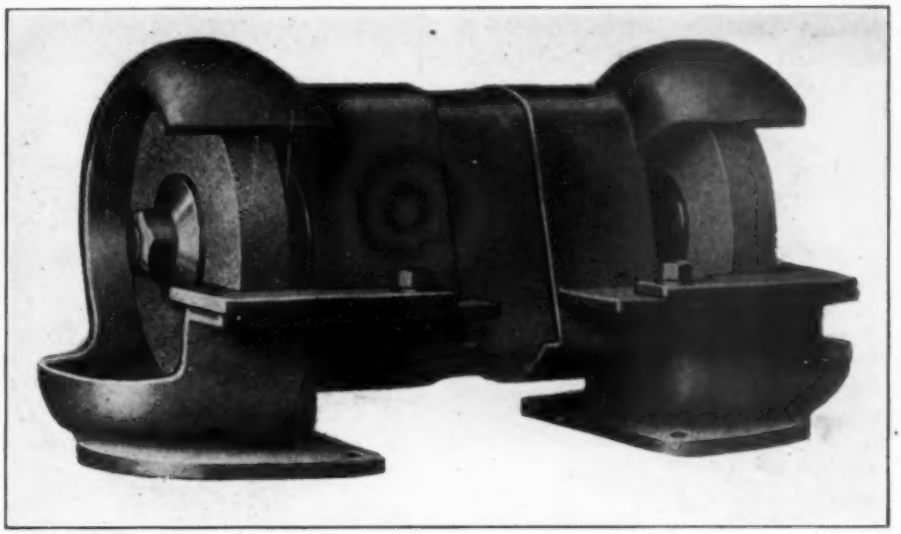


TWO IMPELLERS ROTATE ON PARALLEL SHAFTS WITHIN THE CYLINDER

closed without greatly increasing the pressure but with positive pressure blowers if the discharge is restricted the pressure increases and greatly overloads the blower unless a relief valve is installed.

Radiation Pyrometer Records Heat

The Thwing Instrument Co., Philadelphia has put on the market a radiation pyrometer with either indicating or recording instruments, the latter being of the single or multiple type. These pyrometers measure temperatures as high as are encountered in iron or steel melting furnaces and may be connected directly and permanently to the furnace by the use of ventilated receiving tubes, one of which is shown in the accompanying illustration. In this pyrometer the radiations of heat are focused down the sides of a plain conical mirror upon the blackened junction of a thermocouple. It is claimed that all radiations which enter the cone reach the bottom and pass through a small opening upon the thermocouple regardless of the angle at which they enter the cone. Therefore the instrument is claimed to require no focusing. The thermocouple is made exceedingly small so that it will respond quickly, and is said to reach equilibrium in 10 seconds.



THE WHEELS EXTEND BEYOND THE MOTOR FRAME TO OBVIATE INTERFERENCE

Builds Bench Grinder

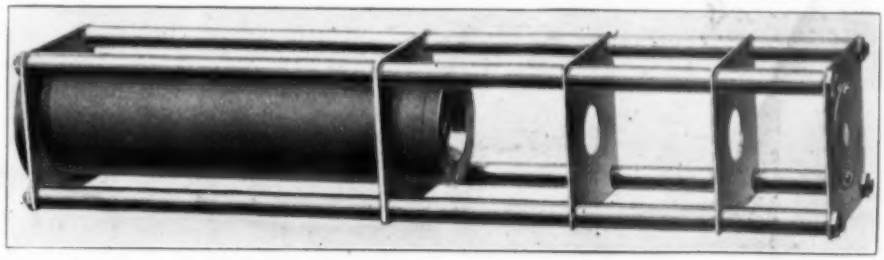
On bench grinders it generally is necessary to incorporate a motor approximately as large in diameter as the grinding wheels to obtain the necessary operating power. Such a motor sometimes interferes with the grinding operation, especially in handling work that must be fed past the wheel, or in grinding various types of tools.

This difficulty has been overcome in the grinder shown in the accompanying illustration, built by Forbes & Myers, 172 Union street, Worcester, Mass. It is equipped with a squirrel-cage, induction motor with the windings at the rear only, which leaves ample space between the two grinding wheels for the easy manipulation of the work.

The machine accommodates 6-inch wheels which project 1¼-inch beyond the motor casing. Thus it is possible to utilize three-fourths of the material in the wheels before they are worn to a level with the motor. The design also makes it possible to grind on both sides of the wheel. The grinding wheels are protected by ample guards, while the tool rests are flat steel, adjustable in two directions. The spindle is ¾-inch in diameter operating in ball bearings. The wheel flanges are of large size, while the motor and bearings are enclosed. The motor develops ½-horsepower at 3600 revolutions per minute operating on two or three-phase, 60-cycle current for 110, 220, 440 and 500 volts.

Heavy Duty Plant Truck Has Power Lift

An electric elevating platform truck, designed particularly for steel plant and foundry work and having a capacity of 5 tons, has been built recently by the Atlas Car & Mfg. Co., Cleveland. The load platform of this truck, which is shown in the accompanying illustration, has a length of 86½ inches, is 30 inches wide and stands 11½ inches from the floor in the lowest position. The height of elevation is 4 inches. Overall sizes are length 11 feet 8 inches and width 4 feet, the inside turning radius being 5 feet 9 inches and the outside turning

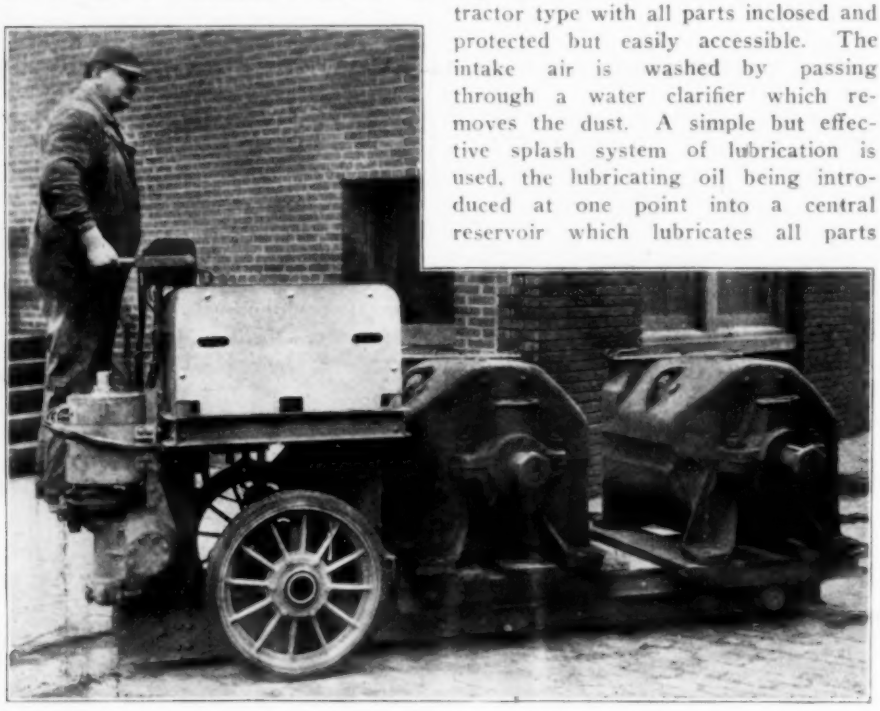


VERTICAL TYPE RECEIVING TUBE FOR STATIONARY INSTALLATIONS OF THE RADIATION PYROMETER

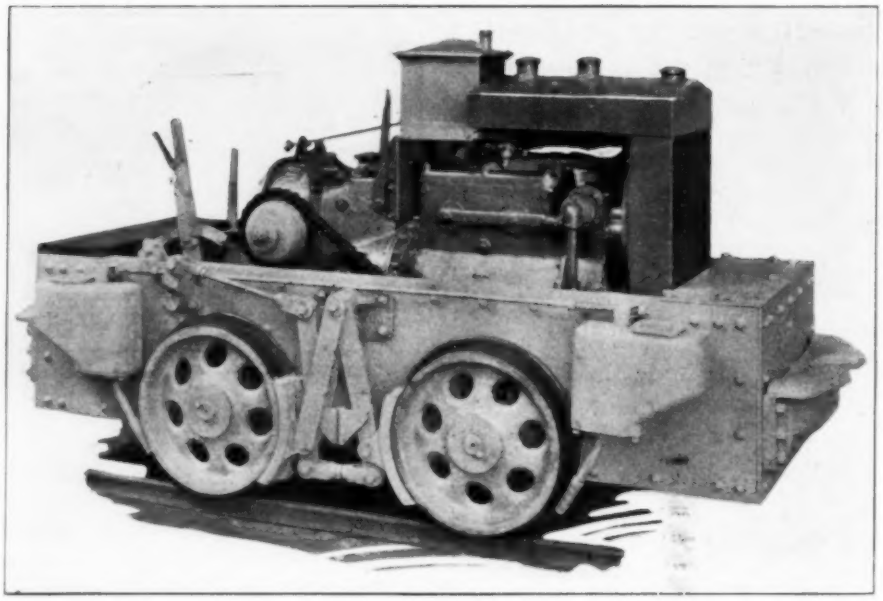
radius 12 feet. Intersectional aisles through which the machine will operate carrying a core rack 61 inches wide and 7 feet long are 8 feet wide.

Metal base rubber tires 27¾ inches in diameter are provided on the driving wheels, giving a speed of 700 feet per minute or 8 miles per hour unloaded. The trailing or load carrying wheels are of steel with a 11¼-inch diameter tread and revolve on double row ball bearings. Steering is applied to all four wheels. Driving shafts and universal joints are removable from the outside and are held in place by bolted clutch plates. Driving reduction is by means of an inclosed worm and wheel, the motor being coupled flexibly to the worm. A contracting type shoe brake is supplied and interlocks with the foot pedal lever and controller safety switch in such a manner that the brake is applied each time pressure is removed completely from the foot pedal. The controller allows three speeds in either direction. Complete safety features are provided.

The battery compartment is provided with lift-off end plates and rails for guiding and holding the storage battery trays. Either iron plate or lead plate batteries may be used, 42 cells of the former or 24 of the latter being required. The elevating mechanism consists of a motor flexibly coupled by a double worm reduction to four crankshafts which when revolved simultaneously one-half revolution cause the load platform to lift 4 inches in a vertical direction. The rated load of 5 tons is elevated 4 inches in 10 seconds. To lower the load, the motor is reversed. Moving a small handle up or down raises or lowers the load, a limit switch on the platform operating automatically.



INDUSTRIAL STORAGE BATTERY TRUCK WITH AN ELEVATING PLATFORM HAVING A LIFT OF 4 INCHES



SMALL GASOLINE LOCOMOTIVE BUILT FOR INDUSTRIAL AND PLANT SERVICE

Manufactures Gasoline Locomotive

To meet the demand for a compact gasoline locomotive for light industrial haulage service, the Atlas Car & Mfg. Co., Cleveland, is building a substantial machine designed to withstand severe service. A side view of the locomotive is shown in the accompanying illustration. The engine is of the tractor type with all parts inclosed and protected but easily accessible. The intake air is washed by passing through a water clarifier which removes the dust. A simple but effective splash system of lubrication is used, the lubricating oil being introduced at one point into a central reservoir which lubricates all parts of the motor and the transmission.

The clutch is placed just behind the flywheel in the usual manner and the driving shaft mounts at its extremity, a bevel pinion which is in constant mesh with two bevel gears, causing the gears to rotate in opposite directions. Forward or reverse motion is obtained by engaging one of the bevel gears by means of a sliding gear clutch. Drive from the bevel gear shaft is by a gear reduction to the jack shaft on the extremities of which are mounted sprockets which drive the axles through roller chains. The entire mechanism is simple. A standard locomotive frame similar to that used on electric mine and industrial locomotives supports the power plant. Complete locomotive equipment is provided, including hand-operated brakes with renewable brake shoes, hand-operated sanders and locomotive-type bumpers. Speed changes are obtained by a throttle control similar in operation to that used on steam locomotives. All control levers are grouped conveniently in the operator's compartment. Cast iron wheels are standard equipment but steel wheels or steel-tired wheels as well as a cab for inclosing the driver and mechanism can be provided.

Goggles Must Be Worn

The importance of wearing goggles where required is emphasized in a recent decision by Federal Judge Witmer who rendered a verdict in favor of the American Car and Foundry Co. in a suit brought by an employe against the company for the loss of an eye. The evidence showed that he had been provided with goggles but had foolishly discarded them thus releasing the company from any responsibility.

Induction Furnace for Nonferrous Metals

An induction type furnace which is particularly adapted to melting nonferrous metals recently has been developed and operated for several months by the General Electric Co. The melting chamber, in which the charge is received, melted and held for pouring, resembles an ordinary crucible with enclosed top. It has a charging door on one side and a pouring spout on the other, also a door in the cover, which may be used for charging, or as a vent when necessary.

Beneath this chamber, and communicating with it through ports, is another chamber in the form of a hollow cylinder encircling a primary winding and one leg of a laminated iron core. Molten metal in this cylindrical chamber constitutes the secondary of a transformer, and the heat in the furnace is generated by the secondary current which flows around the cylinder, through the resistance of the molten metal, when alternating voltage is applied to the primary winding. The refractory lining for this furnace is constructed of three pre-formed and pre-fired parts which are assembled with cemented joints in the furnace.

When starting the furnace, it is necessary to prime it with sufficient molten metal to fill the secondary and give a depth of 2 or 3 inches in the melting chamber. The furnace therefore is best used when operating continuously, on the same kind of metal, as a residual charge must be retained from the previous heat for starting a new one. When melting intermittently, as for day work only, or for a few heats per day, the residual charge must be kept in a molten condition between heats by applying a low voltage sufficient to supply the radiation losses only. If it is desired to change the metal or alloy which is melted, this may be done by emptying the furnace completely and pouring in a priming charge of the new metal, which has been melted in some other furnace or if it is desired merely to change the percentages of the constituents in the alloy, this may be done by adding an increased percentage of one or more of the constituents to correct the proportions of the residual charge.

This furnace will be built in two forms, which are practically the same except for the tilting mechanism and method of tilting. The furnace proper, which is the same in both forms, is mounted on a strong steel frame or yoke, which is provided with trunnions supported in bearings on pedestals. In the form shown in the accompanying illustration the trunnions are so located at opposite ends of the yoke that the furnaces tilts around a line approximately through its center of gravity, the pouring spout moving forward and down. In this form of the furnace, the tilting is accomplished by means of a hand wheel suitably geared to the trunnions. In the other form, the trunnions are located on a line passing through the pouring spout, so that in tilting there is no motion of the spout. The latter type of furnace is used when it is desired to pour directly from the furnace into molds. In this form of the furnace, the tilting is accomplished by a motor which is controlled by a standard drum switch.

ROTATION OF MOTOR NOT CHANGED TO REVERSE DRILL

New Drill Is Reversed Mechanically

The Independent Pneumatic Tool Co., Chicago, manufacturer of pneumatic tools and electric drills, has developed recently a mechanically reversing electric drill. The reverse is operated by a mechanical device placed in the gear case, so that the motor always runs in the same direction. It is claimed that this application eliminates the shocks which formerly resulted when the current was reversed under load and speed. The reversing gear is equipped with what is stated as a fool proof locking device, which can be shifted instantly to permit three motions: First, a locked constant forward motion for general drilling, reaming etc; second, a locked constant reverse motion for backing off nuts etc; and third, a neutral position which allows the spindle to slip into forward motion when the machine is pressed forward.

MOLTEN METAL IN THE HOLLOW CYLINDER ENCIRCLING THE PRIMARY WINDING COMPRISES THE SECONDARY WHICH APPLIES HEAT TO THE MAIN BATH

Increased Inquiry Is Noted

Influence of Strikes Little Felt in the Foundry Equipment Market—Molding Machinery, Cranes, Sand Handling Installations and Cleaning Room Apparatus Moving Briskly

DESPITE discouraging factors which might serve to deter prospective purchasers, a steady and insistent inquiry is noted for all classes of foundry equipment, and more particularly for that which will conserve labor. Sales of machinery for handling materials in the yards, for conveying and transporting within the foundry and for lessening the amount of common labor required in the cleaning room, all show a marked increase. Inquiry for ovens, and cleaning room equipment is brisk. The Foundry Equipment Co., Cleveland, has sold a number of ovens including installations for the Lorain Steel Co., Johnstown, Pa., the Detroit Lubricator Co., Detroit and the Sterling Brass Co., Cleveland. Sand handling and mixing equipment sales recently made by the Standard Sand & Machine Co., Cleveland include the Penn Mold & Mfg. Co., Dover, O., the Saginaw Malleable Iron Co., Saginaw, Mich. and two machines to the American Radiator Co. for its Buffalo foundry. F. A. Coleman Co., Cleveland recently sold four ovens to the Flint Foundry Co., Flint, Mich., four to the American Malleables Co., Owosso, Mich., and three to the Apex Brass Mfg. Co., Cleveland. The Pangborn Corp. Hagerstown, Md., recently has sold sand blast installations to the Michigan Malleable Iron Co., Detroit; Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; Eastern Malleable Iron Co., Troy, N. Y.; Standard Steel Car Co., Hammond, Ind.; Nordyke & Marmon Co., Indianapolis;; Ingersoll-Rand Co., Phillipsburg, N. J.; Malleable Iron Fittings Co., Branford, Conn.; Goulds Mfg. Co., Seneca Falls, N. Y.; Bucyrus Co., S. Milwaukee, Wis., and General Electric Co., Schnectady, N. Y. F. J. Ryan & Co., Philadelphia, is carrying on tests of heat treating furnaces at the plant of the United States Cast Iron Pipe & Foundry Co. to handle centrifugal castings.

Strikes Affect Pittsburgh Market

SINCE foundry operations in the Pittsburgh area are noticeably affected by combined railroad and coal strikes, mainly through a shortage of coke, a slackening in the inquiry rate on foundry equipment is noted. Sales also have dropped off. The occasional orders received in this territory are relatively unimportant and in connection with ladles, tumbling barrels, etc., are not as numerous as in July. However, some small units of foundry equipment continue to be sold from time to time. One buyer in Allegheny closed on an electric sand sifter recently and one in Coraopolis, Pa., purchased similar equipment. The Fox Furnace Co., Elyria, O., closed on another lot of four 1-ton hoists with the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. The sale of facings, core binders, etc., has been greatly interfered with by curtailed operations among foundries, one of the largest to shut down being Valley Mold & Iron Corp. While considerable activity is reported in molding machines, here too, a slump in inquiries is noted. This is attributed to the general let up in business superinduced by the strikes, vacation periods, etc. Among orders recently received for molding machines by the Herman Pneumatic Machine Co., Zelienople, Pa., are the following: American Radiator Co., Buffalo, two rollover machines; Ohio Steel Foundry Co., Lima, O., large rollover machine; Lima Locomotive Works, Lima, O., large jarring rollover machine; Westinghouse Electric & Mfg. Co., Trafford City, Pa., large jar stripping plate machine; Oil Well Supply Co., Oil City, Pa., jar-stripping plate machine; American Manganese Steel Co., Chicago Heights, Ill., large jarring machine; Locomotive Finished Materials Co., Acheson, Kans., plain jarring machine; and the American Steel Foundries, Pittsburgh, jarring machine. Some of these transactions were entirely consummated by telegram; inquiries were wired in, quotations were telegraphed back and the orders were filed by wire, indicating the prompt need of molding machines for special work. Two or three cupola propositions still are up for attention, one inquiry calling for a blower, electric traveling crane, core oven and tumbling mill in addition to the cupola. Another inquiry hanging fire here for some time involves a complete foundry equipment installation. Early action is expected on a shelf type core oven as well as on one or two other core oven inquiries. One foundry interest is in the market for a 6-ton electric jib crane and the United Engineering & Foundry Co. has been taking bids on one 40 and two 10-ton cranes. The Northern Engineering Works, Detroit, recently sold a 75-foot crane to the Crane Co., Chicago, and one 15-ton and three 5-ton cranes to the Monitor-Bi-Loop Radiator Co., Lancaster, Pa.

Better Buying in the East

BUSINESS in the eastern foundry equipment market in early August has been more active than in July. Few outstanding orders are reported but the aggregate is better. Included in recent buyers are the Chenung Iron & Steel Co., Elmira, N. Y., which closed on a 7-ton ladle; the Colvin Foundry Co., Providence, R. I., a 6-ton ladle and the Warren Foundry & Machine Co., Philipsburg, a 8500-pound ladle, this business going to the Whiting Corp., Harvey, Ill. Complete equipment for a brass and gray iron foundry in Guayaguil, Equador, and a cupola for the American Brakeshoe & Foundry Co., Baltimore, have also been placed with the Whiting Corp. A large sand cutter has been placed by the Packard Motor Car Co., Detroit, with a New York City concern. The Oneonta Iron Works, Oneonta, N. Y., has closed on a 5-ton electric crane, 40-foot span, to the Euclid Crane & Hoist Co., Wickliffe, O., and the M. W. Kellogg Co., Jersey City, has purchased a 3-ton handpower crane from the Armington Engineering Co., Euclid, O. The Michigan Brass & Copper Co. has also purchased an electric overhead crane, one of 5-ton capacity, the order going to the Niles-Bement-Pond Co., 111 Broadway, New York. The American Radiator Co., Buffalo, closed on three small cranes to an unnamed builder. Prospective crane buyers are the Ferral Foundry & Machine Co., Ansonia, Conn., in the market for a 5-ton electric crane, and the United States Cast Iron Pipe & Foundry Co., Burlington, N. J., inquiring for a 10-ton, 2-motor ladle crane. The Essex Foundry Co., Newark, is expected in the

market shortly for some miscellaneous equipment for a new plant addition, and the Nekoosa Iron Works, Nekoosa, Wis., is also understood to be contemplating the purchase of some new equipment. Included in new projects reported in this district is a branch plant at Davenport, Ia., for the N. O. Nelson Mfg. Co., St. Louis, manufacturer of pipe and plumbing supplies, and a foundry for David Round & Son, Cleveland.

Foundry Construction Increases

ACTIVITY in foundry construction and equipment in some spots is showing more activity than for some time. Difficulties of the present general business situation have caused some setbacks through suspended orders and cancellations of castings contracts, but this has not been sufficient to discourage foundrymen in general. Construction of the new Pullman foundry at Pullman, Ill., is to go ahead at once, the contract for the steel construction having been let to the W. B. Kilgore Construction Co., About 1000 tons of steel is required. Part of the Campbell, Wyant & Cannon foundry at Muskegon will be in operation soon and equipment is being installed rapidly in the entire plant. Continuous types of mold conveyors, sand handling and core ovens are being provided. Overhead cranes and cleaningroom equipment have not been bought. A. A. Wickland & Co., Chicago, are in charge of construction and equipment. The new unit will have a capacity of 400 tons of cylinder castings per day. The same engineers are remodeling the Des Plaines foundry at Des Plaines, Ill., and installing new cupola, sand blast and cleaning room. Buying of cupolas is being done, one maker having placed five in the past few days, all small units for school and college foundries. Ladles are also in steady demand, both small and large. The Thomas Furnace Co., Milwaukee, has bought from the Whiting Corp., a 25-ton electric reservoir ladle for use at its blast furnace. The same seller has booked orders for a number of cranes of various types. The Westinghouse Electric & Mfg. Co., Pittsburgh, has bought from this maker a 4-ton handpower crane, the Long Island railway, Jamaica, N. Y., an electric crane of 150 tons capacity, 59 feet span; and the Lehigh Structural Steel Co., Allentown, Pa., a 10-ton electric crane; The Bucyrus Co., South Milwaukee, Wis. has purchased an oven installation from the Foundry Equipment Co., Cleveland. Other sales by the same interest include ovens for the H. Mueller Mfg. Co., Decatur and the Cadillac Malleable Foundry Co., Cadillac, Mich. The International Harvester Co., Chicago has purchased new sand handling and mixing machinery from the Standard Sand & Machine Co.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

The National Sanitary Co., Salem, O., is planning to rebuild its plant here which recently was damaged by fire.

The Canton Malleable Iron Co., Canton, O., is reported planning to enlarge its plant by the erection of an annealing building.

The building occupied by the Acme Pattern Works, Puget Sound Mfg. and the Puget Sound Metal Works, Tacoma, Wash., recently was damaged by fire.

The Topton Foundry Co., Topton, Pa., manufacturer of iron and steel castings, etc., has work under way on the erection of a plant building. Nathan Kline is head of the company.

D. Round & Son, Cleveland, are reported planning the erection of foundry building, 2-stories, 52 x 275 feet, to be erected at an estimated cost of $50,000.

Capitalized at $22,000 the New England Brass Mfg. Co., Danbury, Conn., recently was incorporated by Mohammud Inamruddin, Frank Peon and M. E. Krebbs.

The Modern Brass Foundry, 1319 Bates street, Indianapolis, is planning to rebuild its furnace room which recently was damaged by fire.

The National Malleable Castings Co., Halmes avenue and Michigan street, Indianapolis, plans to rebuild the portion of its plant which recently was damaged by fire.

Erection of a modern foundry and machine shop is planned at Akron, O., by the Ohio Pumping Machinery Co. which will move its business from Fitchburg, Mass.

Erection of a 1-story addition to its plant to be 84 x 110 feet, is being planned by the Essex Foundry Co., Murray street, Newark, N. J., manufacturer of cast iron pipe, etc.

The Burnham Boiler Corp., Irvington-on-Hudson, N. Y., is reported arranging a list of equipment for installation in a foundry and machine shop at Lancaster, Pa.

Work is expected to be started soon by the Calumet Tank & Mfg. Co., Hammond, Ind., on the erection of a foundry building, 1-story, 60 x 130 feet, which will be built at an estimated cost of $75,000.

Installation of additional equipment, including annealing ovens, etc., is planned by the Jamestown Malleable Products Co., Tiffany avenue, Jamestown, N. Y. H. E. Kies is general manager of the company.

W. W. Rosebraugh, Salem, Oreg., has plans under way for the rebuilding of his machine shop, foundry and boiler works, at Seventeenth and Oak streets, Salem, Oreg., which was recently damaged by fire.

The Coy Valve Co., Chehalis, Wash., recently organized with a capital stock of $500,000, is selecting a site on which it plans the erection of a plant to be devoted to the manufacture of valves and other metal specialties.

W. S. Lehrman Pattern Works, Allentown, Pa., recently removed its plant from 600 Turner street, to 15 North Church street, where increased facilities will be arranged including a department for experimental work in pattern design.

The Zenite Metal Co., 201 North West street, Indianapolis, has awarded a contract to the Service Construction Co., Indianapolis, for the erection of a 1-story plant addition, 100 x 200 feet, to be erected at an estimated cost of $100,000 including equipment.

The Rentschler Specialty Works, Inc., 4546 Ravenswood avenue, Chicago, recently was incorporated with a capital stock of $25,000, to engage in the manufacture of dies, castings, etc. The company is represented by Mack, Koepke & Lowes, 11 South La Salle street, Chicago.

The Harrison Safety Boiler Works-Cochrane Corp., Seventeenth and Clearfield streets, Philadelphia, is completing the erection of a foundry, 100 x 352 feet, at Earnest Station, Norristown, Pa., which will replace its plant recently damaged by fire.

Fire, caused by lighting, recently damaged a part of the plant of the Balbach Smelting & Refining Co., 580 Market street, Newark, N. J. It is understood it will be rebuilt. Emil E. Dieffenbach is general superintendent of the company.

Contract for the erection of a 2-story plant addition has been awarded by the American Metal Moulding Co., 141 New Jersey Railroad avenue, Newark, N. J., to Enstice Bros., 111 Academy street, Newark. Gustave A. Johnson is president of the company.

The Rockford Malleable Iron Works, Rockford, Ill., has awarded a contract to the Austin Co., 208 South La Salle street, Chicago, for the erection of a 1-story foundry building, 150 x 200 feet, with an extension, 90 x 120 feet. It is estimated the building will be erected at a cost of $100,000 including equipment.

A foundry has been added to the plant of the Fitchburg Screen Plate Co., Fitchburg, Mass., and work for paper mills throughout the country is being made a specialty. The company has been a manufacturer of screen plates for paper mills. Walter S. Hall is treasurer and general manager of the company.

The Roberts & Mander Stove Co., Eleventh and Washington streets, Philadelphia, has awarded a contract to the Austin Co., Bulletin building, Philadelphia, for the erection of a 2-story plant building at Hatboro, Pa., to be 125 x 185 feet, and be built at an estimated cost of $50,000.

Nicholas W. Akimoff, Harrison building, Philadelphia, mechanical engineer, has plans under way for the erection of a one and 2-story factory building, 100 x 500 feet, at Fifth and

Water streets, Gloucester City, N. J., to be devoted to the manufacture of diesel engines and parts. A company, headed by A. W. Grant is being organized to operate the plant.

Walter C. Jacobs, 9 Campbell street, Newark, N. J., operating a foundry, has started work on the foundations for a 3-story plant building at 63-73 Warren street, Newark, for which the contract recently was let to the American Concrete Steel Co., Essex building, Newark. It is estimated the new foundry will represent an investment in excess of $50,000.

The Lockport Foundries Corp., Lockport, N. Y., has plans under way for the erection of additions to its plant. It has acquired control of the Jefferson Union Co., Lexington, Mass., manufacturer of pipe unions, etc., and plans to enlarge its works at Lockport to accommodate this branch of manufacture. Robert E. Bryant is treasurer and general manager of the company.

The Production Pattern & Equipment Co., Milwaukee, has moved its plant and offices from 92-94 Second street, to the new building at Broadway and Erie streets, Milwaukee, where it occupies 15,000 square feet of floor space. The company manufactures patterns, molding machines, flasks, core driers and other foundry appliances and equipment. P. E. Keller is secretary-treasurer and manager of the company.

New Trade Publications

GAS CALORIMETER—Herman A. Holz, testing engineer, 17 Madison Ave., New York, has issued an 11-page booklet giving full descriptions of a gas calorimeter being sold by him. A few of the advantages claimed for this instrument are that it is operated independently of water supply and waste pipe; the heating value of samples of gas as small as 20 cubic centimeters can be determined readily and accurately; heating value of gas that cannot be brought to combustion in a bunsen burner can be accurately measured; the entire apparatus is self-contained in one convenient carrying case. It is stated that over 400 of these calorimeters are already in use in Europe. The apparatus is said to be so simple in operation that even persons of little or no experience in chemistry and calorimetry can use it successfully and with accurate results. The book includes several diagrams and also directions and suggestions for the calculation of heating value, volume of gases to be used in determinations, etc.

RADIATION PYROMETERS—The Thwing Instrument Co., Philadelphia, has recently published a fifteen page illustrated booklet on high duty radiation pyrometers. The instrument consists of a receiving tube which collects both the dark and the luminous radiation from the hot body on a conical mirror which in turn concentrates them on a highly sensitive black thermocouple. Thermocouple is connected by wireless with a galvonometer to measure the current generated in it by the radiations. Some of the advantages claimed for this pyrometer are that it is accurate to the highest known temperature; since no part enters the fire it is unusually durable; it requires only 10 seconds after being pointed at a hot object before it reaches equilibrium. The instrument may be obtained equipped with a recorder which will make three records at a time. It is said that this recording radiation pyrometer has been used successfully for regulating the firing of a rotary kiln. The portable radiation instrument is recommended for determining firebox temperatures under boilers as it may be carried quickly from one boiler to another. It has also been used for the reading of temperatures of steel in crucibles and while being hardened.

MOLDING MACHINES—The Adaptable Moulding Machine Co., Birmingham, England, has issued an attractive folder containing 13 diagramatical illustrations showing the construction and use of these molding machines. One photograph shows a rollover machine that can be used either as a molding or core making machine. Six views are given of a standard machine. The first is a complete diagram with notes, the second shows the machine closed to a minimum of 12 inches, the third shows it extended to 19 inches, the fourth shows it in ramming position mounted with pulley pattern plate, the fifth shows the same machine in drawing position, the sixth shows it extended to 18 inches. Another photograph shows a large machine fitted with turnover attachment and adaptable draw frame. Half a dozen other illustrations show sand sifters, rollover machines, core machines, cast iron, and pressed steel flasks, snap flasks and several castings made on these machines.

BRASS MELTING FURNACE—F. H. Niles & Co., Woolworth building, New York City, have issued an illustrated leaflet giving the principal characteristics of the electric oscillating brass melting furnace, manufactured by the Hawley Down Draft Furnace Co. The furnaces are built in but one size at present, that is 1200 pounds capacity, operating at 150 kilovolt amperes. However, two other sizes now are being designed and will be put on the market shortly. They are as follows: Six hundred pounds capacity, 75 kilovolt amperes and 2500 pounds capacity, 300 kilovolt amperes.

BLOWERS—The Connersville Blower Co., Connersville, Ind., has published a 4-page illustrated booklet in which positive pressure blowers are described and illustrated. These blowers are of relatively small capacity but have many fields of usefulness in furnishing air for oil and gas furnaces and appliances, blacksmith forges, pneumatic conveying, flotation mills, activated sludge systems, agitating water in raw water ice plants and in filter beds; also producing a vacuum for vacuum cleaning, paper folding machinery, vacuum pressing machines and priming centrifugal pumps. They are adapted to moving air under pressures of ½ to 5 pounds per square inch or vacuums of 1 to 10 inches mercury. Design and construction of the blowers is given in detail in the booklet.

SAND BLAST EQUIPMENT—The Northern Blower Co., Cleveland, has issued an illustrated leaflet describing its sand blast rooms and other equipment. A ceiling made of angular shaped plates provides ventilation in the sand blast room without permitting the sand to fly out. Each room is equipped with a double hopper taking the dirt out through the floor thus keeping dust and dirt from the operators head. Illumination, sand blast cars, turntables, cabinets and sand blast tanks also are described.

PNEUMATIC TOOLS—The Chicago Pneumatic Tool Co., New York, has published a large illustrated folder in which pneumatic tools and equipment are described and illustrated. The tools described include grinders, drills, air hoists, chipping hammers, steam engines, compressors, riveting hammers, bolt drivers, holder-ons, etc. A second bulletin containing the same line of descriptive matter, but many more illustrations of the tools in actual use, has also been published by the company.

POWER HOE—The Link-Belt Co., Chicago, has published a 24-page illustrated booklet in which a power hoe for use in bulk material storage, is described and illustrated. The booklet is replete with illustrations showing the hoe in action. A number of line drawings are also given.

LIFTING MAGNET—The Ohio Electric & Controller Co., Cleveland, is circulating 16-page illustrated bulletin in which mill type lifting magnets are described and illustrated. This bulletin supersedes a former one and shows changes in magnets including increase in physical diameter. Improvements as pointed out in this bulletin include all impregnated asbestos insulation; all electric joints braze-welded, no through holes in outer ring which is of massive cross-section and will not break; flexible leads brought out through water-tight stuffing boxes and fully protected. In addition to the magnet a two-unit magnetic switch magnet controller is described. The magnet cable is also described. Illustrations show the magnets in actual use.

FLEXIBLE COUPLINGS—The Thomas Flexible Coupling Co., Warren, Pa., has published an illustrated booklet in which flexible couplings for all direct-connected machines are described and illustrated. The coupling is simple in construction. Between two end flanges is interposed a center member, this being connected to the flanges by laminated flexible steel disc rings, which in turn are bolted alternately to the center member and end flanges. The discs are circle rolled and specially treated so as to insure long life without crystallization. The illustrations show these couplings operating a 132-inch plate mill at the plant of the Brier Hill Steel Co., Youngstown, O. Double flexible and single flexible couplings are described in the booklet. The former are designed for heavy-duty rolling mill and air compressor drives, etc., while the latter are for high and low speed heavy-duty line shaft drives and three-bearing direct connected units where only angular and endwise floats are to be compensated.

ELECTRIC FURNACES—The Ajax Metal Co., Philadelphia, has published a 16-page illustrated booklet in which electric furnaces are described and illustrated. Various characteristics of the furnaces are treated in the booklet in a brief, nontechnical fashion. The furnace is built in two types, nose tilting and ladle pouring. The nose tilting type is counterweighted and rotates about the center of the spout. This type, while primarily designed for rolling mill work now is being used by general founders. The ladle pouring type tilts about the center of gravity or slightly above it when empty. When fully charged the revolving center is slightly below the center of gravity. Both types are rugged. The floor space required is only 5 feet x 5 feet. There are two charging doors, one in the rear and one in the top. The standard size furnace is 60 cycles, 220 volts, single phase.

CRANES—The Industrial Works, Bay City, Mich., has just published an attractive 96-page illustrated catalog in which its various lines of cranes are described and illustrated. These include locomotive, wrecking, wharf, gantry, transfer and pillar cranes, combination crane pile drivers, rail saws, grab buckets, transfer tables and steam pile hammers. The data given are interesting and the illustrations show the various equipment in actual operation. The last few pages of the book contain a small description of the company's plant.

PORTABLE TOOLS—The Stow Mfg. Co., Binghamton, N. Y., is cirulating a 4-page illustrated folder in which portable electric tools are described and illustrated. These include drills, grinders, boring machines, buffers, etc. Specifications of the various tools are given.